

And we know that in all things, God works for
the good of those who love him, who have been
called according to his purpose

(Romans 8:28)



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Orthodontic MINISCREW Implants

CLINICAL APPLICATIONS

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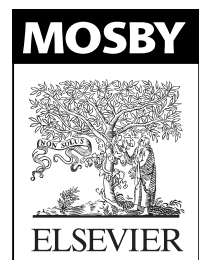
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PREFACE

The idea of writing of this book began when we made a presentation at a meeting of the Southern Californian Component of the Edward H Angle Society of Orthodontists, of which two of the authors, Cheol-Ho Paik and In-Kwon Park, are members. Immediately after the meeting, we were offered an opportunity to publish a textbook on the orthodontic miniscrew implant. We would like to thank Dr Richard P McLaughlin and Dr John C Bennett for encouraging us in writing this textbook.

Orthodontic movements that are considered difficult to accomplish with traditional methods can be achieved with minimal patient cooperation by using miniscrew implants. This book brings together our knowledge and experience of using miniscrew implants in orthodontic practice. As practicing orthodontists, we have mainly focused on the clinical applications of the miniscrew implant, illustrated with cases treated at our clinic. Details of basic research have been kept to a minimum, as the book is designed to be an easy to read guide, aimed at the orthodontist wishing to adopt miniscrew implant anchorage in their everyday practice. We have attempted to demonstrate how miniscrew implants can be used to simplify orthodontic treatment.

We remember an impressive case presented by an orthodontic resident more than 10 years ago. The patient, who presented with the complaint of mild crowding of his front teeth, had undergone bimaxillary surgery following a reassessment of his malocclusion midway through his orthodontic treatment. This was required because with the orthodontic leveling of the teeth his underlying mild vertical skeletal excess led to the development of an anterior open bite with asymmetry. If orthodontic miniscrew implants had been available back then, a small amount of intrusion and retraction of the dentition using miniscrew

implant anchorage might have helped complete the treatment without the need for orthognathic surgery.

Skeletal Class II malocclusions with vertical excess are common in the Caucasian population, and such patients are often treated with orthognathic surgery involving maxillary impaction and autorotation of the mandible. However, this aggressive procedure may be substituted by intrusion of the maxillary dentition using midpalatal miniscrew implant anchorage. This is one of the reasons we have written this book in English. Our work will be worthwhile if even a few patients are spared unnecessary orthognathic surgery with the help of the orthodontists who read this book.

In Asian populations, Class III malocclusions are more common. However, many of these patients have mild to moderate Class III malocclusion and orthognathic surgery is not always an acceptable treatment option. In such patients, miniscrew implants can be used very effectively to retract the entire mandibular dentition. In South Korea, most of the orthodontists use miniscrew implants in daily clinical practice. This phenomenon is unique, and it may have been triggered by the publication in 2001 of a textbook on the microscrew implant in Korean by Dr Hyo-Sang Park.

We specially thank Dr Youn Sic Chun, Dr Jong-Suk Lee and Dr Jong-Wan Kim, who shared their data with us, and we appreciate the passion and commitment of Dr Sungmin Kang, which helped complete the writing of this book in a short time.

Cheol-Ho Paik
In-Kwon Park
Youngjoo Woo
Tae-Woo Kim

KOREAN NORMS AND CEPHALOMETRIC ABBREVIATIONS

DENTAL AND FACIAL CEPHALOMETRIC MEASUREMENTS: KOREAN NORMS

Korean norm	
SKELETAL ANALYSIS	
Anteroposterior	
SNA (deg)	82.0
SNB (deg)	79.8
ANB (deg)	2.2
Vertical	
GoMe/SN (deg)	31.8
FMPA (deg)	23.5
PP/MP (deg)	22.4
Lower gonial (deg)	73.4
ANS–Me (mm)	73.2
DENTAL ANALYSIS	
Overjet (mm)	3.6
Overbite (mm)	1.9
UI/SN (deg)	107.8
L1/GoMe (deg)	96.2
SN/OP (deg)	16.6
Is–Is' (mm)	–
Mo–Ms (mm)	–
li–li' (mm)	–
Mo–Mi (mm)	–
LIP ANALYSIS	
U Lip–E (mm)	–0.7
L Lip–E (mm)	0.5
NLA (deg)	–

DENTAL AND FACIAL CEPHALOMETRIC
MEASUREMENTS: ABBREVIATIONS
USED IN THIS BOOK

SNA	Sella-nasion-point A
SNB	Sella-nasion-point B
ANB	Point A-nasion-point B
GoMe/SN	Gonion-menton/sella-nasion
FMPA	Frankfurt-mandibular plane
PP/MP	Palatal plane/mandibular plane angle
ANS-Me (mm)	Anterior nasal spine-menton
UI/SN	Upper incisor/sella-nasion
LI/GoMe	Lower incisor/gonion-menton
SN/OP	Sella-nasion/occlusal plane
Is-Is' (mm)	Upper anterior dentoalveolar height (UI-NF*)
Mo-Ms (mm)	Upper posterior dentoalveolar height (U6-NF*)
Ii-Ii' (mm)	Lower anterior dentoalveolar height (LI-GoMe)
Mo-Mi (mm)	Lower posterior dentoalveolar height (L6-GoMe)
U Lip-E (mm)	Upper lip-esthetic plane
L Lip-E (mm)	Lower lip-esthetic plane
NLA	Naso labial angle

*NF, nasal floor.

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When Brånemark¹ invented the first successful osseointegrated implant, he certainly would not have envisaged how it would transform the practice of dentistry in the years to come. Such implants have significantly enhanced the scope and quality of dental treatment and to a lesser extent, this has included orthodontic treatment.

For a long time, orthodontists have struggled to achieve efficient control of anchorage. However, their efforts have only had partial success owing to Newton's third law of motion, which states that for each action there is an equal and opposite reaction. A variety of extraoral appliances have been designed to overcome this limitation, but these have their own problems, such as inadequate patient compliance.

Dissatisfaction with conventional methods of anchorage led some pioneer orthodontists to explore the use of implants as a source of absolute anchorage. In 1990, a temporary retromolar implant was shown to work as an absolute anchor to move molars mesially.² In 1995, the midpalatal onplant was proposed as another means of providing absolute anchorage for tooth movement,³ and this has since become an accepted form of treatment mechanics.⁴ From the orthodontic viewpoint these conventional endosseous implants and onplants have many disadvantages, such

as the cost, need for extensive surgery, time required for osseointegration, and limited availability of sufficient bone to act as an implant site. More recently, titanium miniplates have been shown to successfully intrude posterior teeth in patients with skeletal open bite,⁵ but flap surgery for placement and removal is unavoidable. In spite of these disadvantages, osseointegrated implants are proving to be an extremely useful adjunct to conventional orthodontic treatment in a minority of cases.

The miniscrew, which was originally designed to fix bony segments, has shown great promise as a simpler and more versatile solution for obtaining absolute anchorage. Many authors have reported successful use of miniscrews in a wide range of orthodontic tooth movements.⁶⁻⁸ Miniscrews are used as temporary fixtures in bone and their greatest advantage lies in their small size, which permits rapid and atraumatic placement in almost all sites within the mouth. In the past decade, there have been rapid advances in the development of miniscrews and they are increasingly used in orthodontics. It is the authors' goal, and the aim of this book, to popularize the use of the miniscrew implant among orthodontists and to reduce the need for orthognathic surgery in patients with mild or moderate skeletal discrepancy.

CASE EXAMPLE

One of the best examples of the ability of miniscrew implants to open whole new possibilities in orthodontics is in the treatment of anterior open bite with vertical skeletal excess. With these implants,

molars can be intruded to reduce face height, thus avoiding costly and extensive orthognathic surgery. A 30-year-old full-time career woman attended the authors' clinic with the complaint of severe open bite and difficulty biting. On examination she had skeletal vertical excess with incompetent lips (Figs 1.1–1.5).



Fig. 1.1



Fig. 1.2



Fig. 1.3



Fig. 1.4



Fig. 1.5

If this patient had presented in the era before the introduction of the miniscrew implant, the treatment options would have been either the extensive and invasive procedure of bimaxillary anterior subapical osteotomy with simultaneous impaction of the maxilla, or conventional orthodontic treatment with the probability of some degree of post-treatment

dental relapse and no realistic possibility of intruding the molars and therefore reducing the face height. However, this patient was fortunate that her orthodontist offered non-surgical treatment using miniscrew implants. The improvement in esthetics and function following this treatment has remained stable for 3 years (Figs 1.6–1.10).



Fig. 1.6



Fig. 1.7



Fig. 1.8



Fig. 1.9



Fig. 1.10

ABOUT THIS BOOK

This book shows how many of the difficult problems encountered by orthodontists in everyday practice, such as a midline shift or a canted occlusal plane, can be successfully treated with the use of miniscrew implant anchorage. For ease of description, the applications of the miniscrew have been categorized as follows:

- Anteroposterior control
- Vertical control

- Transverse and asymmetry control
- Other applications

Dr Robert M Ricketts said, 'Orthodontics is a profession where one enhances the facial esthetics by using the dentition as a tool.' This is even more valid in the twenty-first century when teeth can be moved much more easily and in a more controlled fashion with miniscrew implants.

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CHAPTER

2

A BRIEF REVIEW OF THE USE OF
IMPLANTS IN ORTHODONTICS

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EARLY RESEARCH AND DEVELOPMENT

In 1945, Gainsforth and Higley¹ first introduced the concept of skeletal anchorage using vitallium ramal screws in dogs. This attempt failed, as did almost all implants of that era, because the metals used were not conducive to the later discovery of osseointegration through titanium, the result being inflammation around the vitallium screw, leading to loosening and loss. Gainsforth and Higley stated, 'While it is hoped that some means of basal bone anchorage may be obtained for orthodontic movement in the future, the results as given in this report do not warrant its use in the manner shown here.' With the publication of this textbook, the authors are confident that we are now living in that future.

In 1969, Brånemark and colleagues^{2,3} introduced the concept of osseointegration in dentistry, using pure titanium implants. Brånemark et al⁴ defined osseointegration as 'living bone in direct contact with a loaded implant surface.' This definition was based on observations made at the light microscopic level. However, few clinicians envisaged the use of titanium implants in orthodontics at that time. It was not until the 1980s, that several animal studies on the use of titanium implants in orthodontics reported successful results. Roberts et al⁵ studied the effects of orthodontic force on titanium implants in rabbits. Of 20 acid-etched titanium implants, 19 remained stable when a force of 100 g was applied. In another study titanium implants were inserted in dog mandibles; 15 of 16 implants remained stable after 13 weeks of continuous loading with 300 g force.⁶ These animal studies were followed by a case report⁷ in which an osseointegrated titanium implant in the retromolar region was used as anchorage to move two molars 10–12 mm mesially through a post-extraction atrophic alveolar ridge.

Further research by Turley et al^{8,9} also suggested the possibility of using the endosseous implant as an anchor in orthodontic tooth movement. These authors first used this implant in dogs⁸ and then in monkeys,⁹ in which they expanded the palate by applying 425 g of force on bioglass-coated ceramic implants. Conventional osseointegrated implants, as used in restorative dentistry, have since become a standard part of multidisciplinary care involving orthodontics, but their use is limited to a minority of cases.¹⁰ This is because they can only be placed in those positions in a dental arch where there is adequate bone, where orthodontic anchorage is needed and can be used, and where a subsequent implant-supported restoration is required.

Creekmore and Eklund¹¹ reported a case in which a vitallium implant was placed just below the anterior nasal spine and used for anchorage. A light elastic thread was tied from the head of the screw to the archwire 10 days after placement of the implant to intrude the maxillary incisors. This early loading of an implant, without the usual wait for osseointegration, was to become a major feature of the later use of miniscrews. In 1985, Kokich et al¹² introduced a novel source of absolute anchorage when they deliberately induced ankylosis of a deciduous tooth which was then used to protract the maxilla in a patient with severe maxillary retrusion.

LATER DEVELOPMENTS

Midpalatal implants

A next step in adapting implant technology to orthodontics was the development of short but otherwise conventional implants to be placed in the midline of the palate. These are now a well-recognized and documented source of anchorage, but are still relatively expensive and complex. They need careful siting in the palatal vault to ensure sufficient bone depth and no contact with the roots of adjacent teeth, and are therefore relatively inconveniently situated for a palatal arch to take advantage of them. These implants are usually 3–4 mm in diameter and 6–10 mm in length. Traditionally, force is applied to the implants after a healing period of 10–12 weeks.^{13,14} Tinsley et al¹⁵ give an excellent description of a typical current use of these implants. Other practical tips can be found in two articles by Cousley and Parberry¹⁶ and Cousley.¹⁷ Case reports abound, with Wehrbein et al^{14,18,19} reporting a case in which absolute anchorage was provided by a palatal implant with a diameter of 3.3 mm and length of 4 and 6 mm, which required far less extensive surgery.

Onplants

Onplants are osseointegrated to the surface of the bone. These are potentially much simpler and are based on the impressive research of Block and Hoffman.²⁰ These authors used a subperiosteal titanium alloy disk, 2 mm thick and 10 mm wide, coated with hydroxyapatite. This disk-type onplant was inserted through a subperiosteal tunnel prepared through a paramarginal incision, which is rather extensive soft tissue surgery. Furthermore, the onplant is designed to be left unloaded for 4 months. It is essentially true that after a further decade, they have yet to emerge as a widely available, commercially marketed product.

The need for osseointegrated implants of any type in the palate has been greatly diminished by the development of miniscrews. Because of the anatomic

shape of the nasal crest – which extends between the anterior and posterior nasal spines – the midpalatal area is now considered to have adequate bone for retention of the miniscrew implant throughout its length. This overcomes the need for either an onplant or a short conventional osseointegrated implant which is restricted to just one palatal site in the anterior of the palate.²¹ The miniscrew implant^{22,23} used in the cases in subsequent chapters of this book requires the least extensive surgery in this or, indeed, in any area.

MINISCREWS

The late 1990s saw the introduction of miniscrews as temporary anchorage devices. In 1997, Kanomi²⁴ reported using a mini-implant for orthodontic anchorage. He used a mini bone screw with a diameter of 1.2 mm and a length of 6 mm, which was designed for fixation of bone plates in plastic surgery. He drilled the bone before placing the miniscrew implant and waited 4 months for osseointegration before loading the implant. Opinion has since varied on the optimum timing of initial loading. The authors prefer to load an orthodontic miniscrew 1 week after the surgery when the soft tissue has healed, and this subject is examined in more detail in Chapter 3. At about the same time, Umemori et al²⁵ used titanium miniplates for anchorage to intrude the lower posterior teeth in patients with skeletal open bite.

In 2001, in Korea, Park²⁶ published a book illustrated with a variety of cases utilizing miniscrew implant anchorage, which attracted the attention of many orthodontists. In the same year, Park et al²⁷ published a case report of a patient with severe bimaxillary protrusion treated with absolute anchorage provided by miniscrews which they called micro-implants. Since then several articles have appeared on the use of different types of miniscrew. In 2003, Park²⁸ reported that the average success rate of miniscrew implant anchorage was as high as 93.3%. He also noted that the midpalatal area offered the greatest stability for miniscrew implants.

Paik et al²² reported successful correction of vertical maxillary excess in a patient with a high mandibular plane angle and retrusive chin. Cephalometric analysis showed that intrusion of the whole maxillary dentition contributed greatly to the result. In another case report, Park et al²⁹ showed correction of anterior open bite by intrusion of maxillary molars using buccal alveolar miniscrew implants. Sugawara et al³⁰ evaluated the results of treatment with the skeletal anchorage system in nine adults with open bite. They reported that the average intrusion of the first and second mandibular molars was 1.7 mm and 2.8 mm, respectively, and that the average relapse rate was 27.2% at the first molars and 30.3% at the second molars.

Meanwhile, Park et al³¹ also published the results of intrusion of supraerupted maxillary molars using miniscrews in patients requiring prosthodontic treatment for an edentulous mandibular ridge. More diverse uses of the orthodontic miniscrew implant continue to be introduced. For example, Chang et al³² developed an indirect way of using the miniscrew implant. They connected the miniscrew implant to the tooth surface via bonding with a heavy rectangular wire, thus establishing the principle of indirect absolute anchorage, which can be biomechanically very advantageous.

Miniscrews have become established as practical, inexpensive, highly versatile sources of orthodontic anchorage. This book is intended to clarify, scrutinize and illustrate the use of miniscrews in a wide range of applications.

TERMINOLOGY

A mention is needed about terminology because accurate terminology is important for clear communication between orthodontists. As with many new technologies, terminology has taken time to rationalize and become more standardized, and this process is still incomplete.

Over the years a variety of terms have been used to describe the orthodontic implant, such as miniscrew,³³ mini-implant,³⁴ microimplant³⁵ and microscrew implant.²⁸ As is explained later in Chapter 4, 'micro' is short for 'microscopic'; therefore, in the authors' view 'mini' seems to be more appropriate. 'Temporary anchorage device' (TAD)^{36,37} is also widely used but this term includes bone plates and short conventional osseointegrated implants in the midline of the palate. 'Miniscrew implant as TAD' seems to be the most unambiguous term, but the authors prefer to use the abbreviated form 'miniscrew implant' or 'orthodontic miniscrew implant'. Further subtypes of miniscrew such as self-drilling and self-tapping and other terminologies are explained in Chapter 4.

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INTRODUCTION

The orthodontic miniscrew implant is a comparatively new and developing clinical tool. Many issues and questions regarding the use of implants are still unanswered or under debate or awaiting research. This chapter aims to acquaint the reader with some of the general concepts and controversies surrounding implants in orthodontics.

METHOD OF INSERTION: DRILL-FREE VERSUS PRE-DRILLING

An important issue regarding the use of miniscrews is the method of insertion. In the drill-free method, a self-drilling miniscrew is inserted directly into the intact cortical bone. In the pre-drilling method, a self-tapping miniscrew is inserted into a guide-hole, which is made using a drill bit.

With the drill-free method, no incision is needed in the attached mucosa, e.g. in the palate or the attached gingiva. The soft tissue in these areas is firm and does not wrap around the screw threads. In the buccal alveolar mucosa a small vertical stab incision through the soft tissue helps prevent the soft tissue from wrapping around the screw threads. In the pre-drilling method¹ a slimmer screw (1.2 mm) is usually used. The main advantage of using pre-drilling and a slim screw is when the screw needs to be inserted in a narrow inter-radicular space. The insertion torque applied to the screw in this method is less than that required for a self-drilling screw as the screw is inserted through a guide-hole rather than intact bone.

Many studies have found that the self-drilling miniscrew is the more favorable option. Heidemann et al² found that the contact between the screw and the bone using self-drilling screws was superior to that with self-tapping screws. Kim et al³ compared the self-drilling 1.6 mm diameter screw (drill-free method) with the 1.2 mm diameter screw inserted after drilling with a bur (pre-drill method). Their research suggested better

stability and greater bone density between the threads of the self-drilling miniscrew. Lundsöm⁴ and Eriksson et al⁵ suggested that the heat produced when the drill bit was used could negatively affect the stability of the screw. Eriksson et al⁵ also reiterated the importance of controlling heat production during surgery to avoid impaired bone remodeling after insertion of the screw.

The authors have used the drill-free method and miniscrews with a diameter of 1.6 mm for all the cases illustrated in this book. The drill-free method is a simpler procedure and offers greater stability of the implant. It has been reported that miniscrews with a relatively greater diameter may induce microfractures of the bone.⁶ However, further research is needed to clarify this issue.

PRIMARY STABILITY: OSSEOINTEGRATION VERSUS MECHANICAL INTERLOCKING

Whether the miniscrew undergoes osseointegration and whether osseointegration contributes to the stability of a miniscrew subjected to an orthodontic force are debatable issues. Osseointegration is defined as a state in which, under the optical microscope, there is direct contact between the implant and bone without any intervening soft tissue, and which enables transmission of the external stresses to the bone structure in a functional manner.^{7,8} In general, studies on dental implants have reported varying amounts of osseointegration. According to Albrektsson et al⁹ osseointegration implies that 90–95% of the implant surface is in direct contact with bone. However, Roberts et al¹⁰ reported that only 23–50% of the implant surface is in contact with bone in the successfully osseointegrated implant.

With regard to orthodontic miniscrew implants, different views have been expressed. Some clinicians have suggested that stability of the orthodontic miniscrew is achieved through mechanical retention, that is interlocking of the miniscrew

threads and cortical bone. Gary et al¹¹ reported that osseointegration may not be necessary when titanium screw implants are used for orthodontic anchorage. Park¹ stated that the stability of the miniscrews comes from mechanical interlocking between the screw and the bone, and not by osseointegration. However, more recent reports^{3,12,13} support the view that osseointegration does occur. Microscopic investigations have indicated that there is at least some osseointegration in the interface between the bone and screw (Fig. 3.1).

However, the amount of osseointegration required for stabilizing the orthodontic miniscrew implant is questionable. It seems that complete osseointegration is not mandatory for orthodontic miniscrew anchorage. The force applied to an orthodontic miniscrew is less than that applied to dental implants. Moreover the miniscrew is a temporary device that is removed after treatment. According to Roberts et al¹⁴ as little as 10% integration at the interface with living bone is adequate for orthodontic anchorage. Deguchi¹⁵ found that even 5% bone contact at the bone–implant interface successfully resisted orthodontic forces in dogs.

Another issue to consider is the effect of osseointegration on removal of the implant. Osseointegration may work as a double-edged sword by increasing the stability of the miniscrew during orthodontic treatment on the one hand but making removal after the treatment more difficult on the other hand. However, removing a screw with a small diameter is relatively easy even if it has osseointegrated because removal torque is proportional to the square of the radius of the screw.³

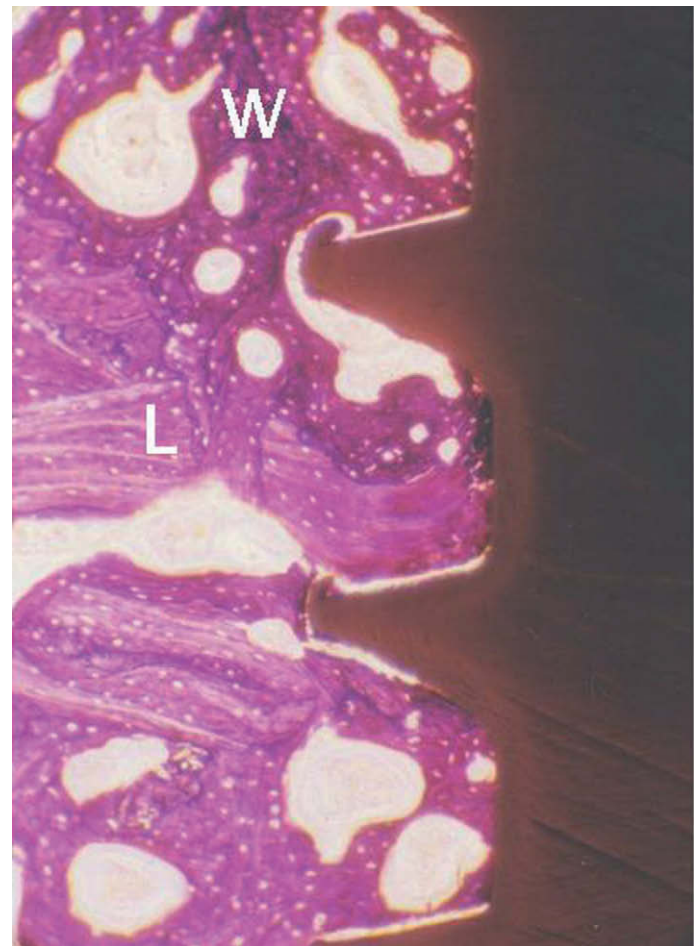


Fig. 3.1 Photomicrograph of a screw in bone. There is woven bone (W) with haversian canals toward the top. The rest is lamellar bone (L). Osseointegration is seen at the interface between the screw and bone (decalcified, H&E stain $\times 250$). Courtesy of Dr Jong-Wan Kim.

TIMING OF LOADING: IMMEDIATE VERSUS DELAYED LOADING

Another issue that has been debated is the timing of loading. The reader should note that waiting for a short period to allow the oral soft tissue to heal after placement of the screw comes in the ‘immediate loading’ category.

It has been reported that the micromotion following early loading interferes with osseointegration.^{16,17} In experiments on rabbit femurs, Roberts et al¹⁰ recommended a 6-week preloading healing period to allow sufficient mature bone to adhere directly to the implant surface. Six weeks in rabbits is equivalent to 4–5 months in humans.

However, many clinicians have shown that the miniscrew can be successfully loaded without having to wait for several months. Creekmore and Eklund¹⁸ applied orthodontic force 10 days after insertion of the implant. Melsen and colleagues¹⁹ performed a histologic evaluation of the bone–screw contact after 1, 3 and 6 months intervals prior to loading based on which they advocated immediate loading. Melsen and Costa¹² loaded 16 titanium vanadium screws with 25–50 g of force immediately after insertion; all but two screws were successfully osseointegrated. Park¹ stated that it is possible to apply orthodontic force once the soft tissues have healed. Huja²⁰ also recommended a short healing period of 1 week prior to loading with relatively light loads (3–5 N [305–510 g]). It is considered important that a low initial loading force is used, less than 50 cN [50 g], if it is applied soon after miniscrew placement. A screw can loosen as a result of application of strain that exceeds the amount that can cause microfractures in the thin cortical bone.^{21,22}

In all the cases presented in this book, the force was applied 1 week after insertion of miniscrew, when the soft tissue had healed.

LOADING CHARACTERISTICS AND IMPLANT STABILITY

The forces acting on miniscrew implants for the purpose of orthodontic anchorage are different from the forces that act on other dental implants. Dental implants are subjected to intermittent occlusal forces that vary in direction and magnitude. Often these forces can be quite heavy. However, the forces applied to the orthodontic miniscrew implant are mostly light, uniform and predictable.¹² Studies evaluating the effect of different loads on osseointegrated implants have shown that static loads (constant loads with uniform force levels) stimulate production of more dense cortical lamellar bone and greater amount of bone–implant contact at the interface than no load or dynamic loads (cyclic loads with variable force levels).^{23–25}

Bone usually adapts to its environment as long as it is loaded within its physiologic range. Figure 3.2 shows

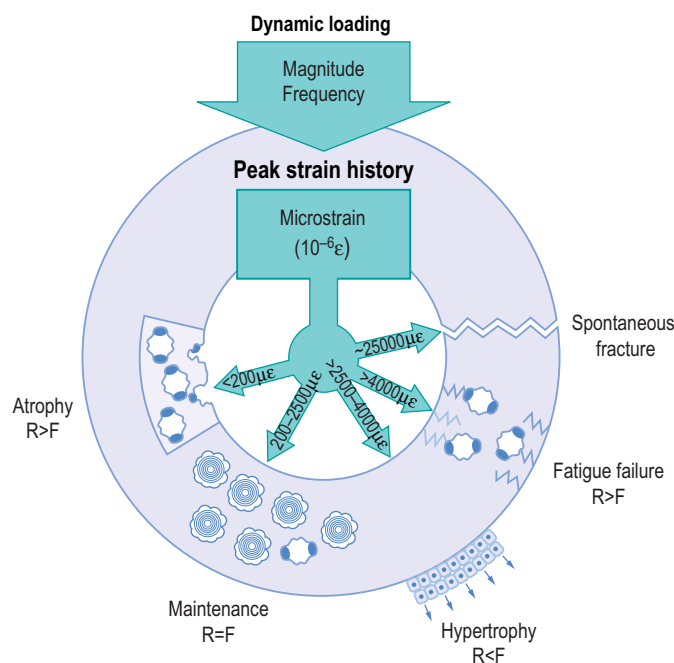


Fig. 3.2 Frost's mechanostat^{26,27} showing the effects of dynamic loading and peak strain history on the structure of bone. R, resorption; F, formation. Redrawn with permission from Roberts W E 2000 Bone physiology, metabolism, and biomechanics in orthodontic practice. In: Graber TM, Vanarsdall RL Jr (eds). Orthodontics: current principles and techniques. Mosby-Year Book, St Louis.

Frost's mechanostat model of bone modeling activity under loading.^{26,27} Strain is a dimensionless parameter, defined as deformation per unit length. For example, when a bone of 100 mm length is elongated by 3 mm the associated strain is expressed as 3% strain, 0.03 strain, or 30 000 microstrain ($\mu\epsilon$). When the bone is subjected to repetitive loading within the physiologic range (200–2500 $\mu\epsilon$), the bone mass remains constant and the bone's structural integrity is maintained by remodeling.²⁸ It is assumed that the light, uniform forces applied to miniscrew implants are within this range. Bone adjacent to an unloaded implant experiences strain of less than 200 $\mu\epsilon$ and may undergo atrophy, whereas if the miniscrew is subjected to intermittent, heavy occlusal loads greater than 2500 $\mu\epsilon$ it may loosen because of bone hypertrophy or fatigue failure (fracture).

SECONDARY STABILITY: BONE REMODELING AROUND THE MINISCREW IMPLANT

Primary stability of miniscrew implants comes from mechanical interlocking with the cortical bone, so the thickness and integrity of the cortical bone are critical factors. Mostly monocortical anchorage is used, although it is possible to use bicortical anchorage (where the screw reaches the cortex on the far side of the medullary bone) in partially edentulous areas and extra-alveolar sites.²⁰ Secondary stability of the miniscrew implant relies mainly on bone remodeling or turnover, which not only maintains the integrity of the osseous support but also provides a continuous flow of calcium necessary for bone metabolism. Remodeling differs from bone modeling in that the latter refers to the changes occurring in a bone's external structure in response to mechanical loading and/or trauma,²⁸ that is changes the shape, size and/or position of the bone.

The duration of the remodeling cycle (sigma) in humans is about 4 months (17 weeks).²⁹ Figure 3.3

shows a sustained high rate of bone remodeling within 1 mm of the implant surface. This bone remodeling is considered to be responsible for the integration and maintenance of the implant in the bone.³⁰ The rate of remodeling around an implant has been reported to be 30% per year, which is almost 10 times that normally seen in adult human cortical bone (3%).²⁹ As seen in Figure 3.1, the orthodontic miniscrew implant seems to be at least partly osseointegrated and remains stable through active bone remodeling, similar to the conventional endosseous implants used in prosthodontics.

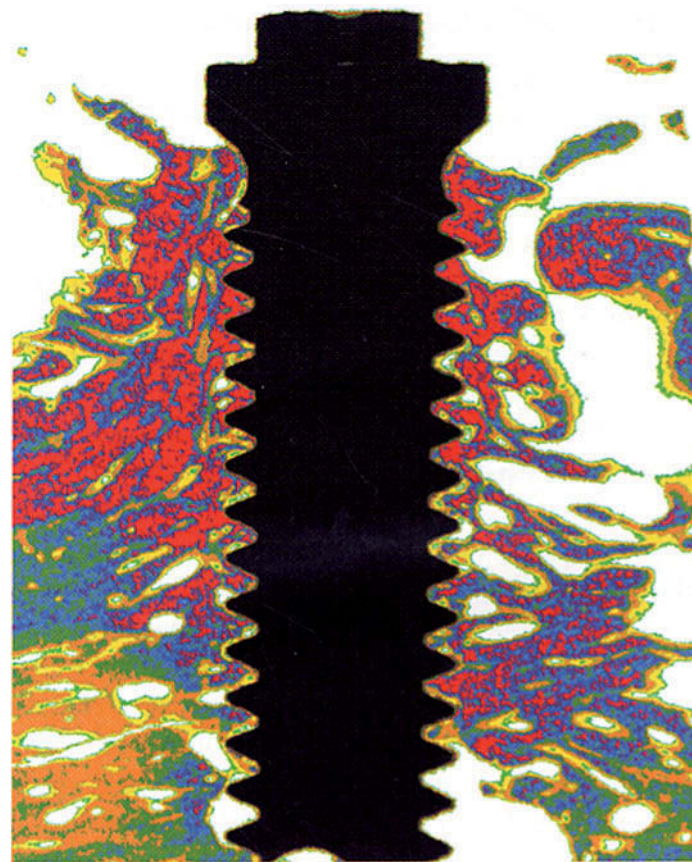


Fig. 3.3 Digital radiomicrograph of a 100 μm thick longitudinal section of a dental implant showing bone remodeling.²⁹ In descending order of bone density the colors are: gold, blue, red and yellow. This morphology is consistent with a high rate of bone remodeling within 1 mm of the implant surface. Reproduced with permission from Yip G, Schneider P, Roberts W E 2004 Micro-computed tomography: High resolution imaging of bone and implants in three dimensions. *Seminars in Orthodontics* 10:174–187.

MINISCREW IMPLANT DESIGN AND INSERTION AND REMOVAL TORQUE

Compared with implants used to replace teeth, the orthodontic miniscrew implant has fewer anatomic limitations and the procedures to insert and remove the screw are much simpler. An ideal miniscrew would require minimal insertion torque so that the screw does not fracture and the bone strain is low. In contrast, the force required to remove it (removal torque) should be relatively large, so that it does not easily loosen under loading. As mentioned above, removal torque is proportional to the square of the radius of the miniscrew implant. The orthodontic implant therefore has lower removal torque and is therefore much more easily removed than implants used for tooth replacement, which usually have a diameter of 4 mm. This is, however, a potential drawback if substantial force is applied to the screw during orthodontic treatment.

Efforts to increase the removal torque led to development of the tapered type of miniscrew, which has a greater diameter near the screw head. According

to a finite element analysis, the conical shape provides better strength and mechanical stability.¹² Another study compared insertion and removal torque of two types of miniscrew design. The tapered type was associated with greater removal torque values, which is preferable for mechanical stability. However, the insertion torque was also greater for the tapered form. This may be a disadvantage of this type of screw as it may result in higher strain in the adjacent bony tissues and miniscrew fracture.³¹ One study found that the dual-pitch design, in which the upper part of the screw has a smaller pitch, helps improve mechanical characteristics, as it is associated with lower insertion torque and greater removal torque than the mono-pitch miniscrew.³²

In the authors' view tapered miniscrews exhibit greater stability in growing patients, in whom active bone remodeling is a risk factor for early loosening of the miniscrew, but more studies are needed to substantiate this observation. The design of the miniscrew implant also needs to be further refined for optimal mechanical stability.

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AND ARMAMENTARIUM

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TERMINOLOGY AND DESIGN FEATURES

Small-diameter implants – miniscrews – are currently preferred for use in orthodontics rather than short palatal osseointegrated implants, conventional restorative osseointegrated dental implants and onplants.

A **screw** is defined as a simple machine that changes rotational motion into translational motion while providing a mechanical advantage. The commonly used screw has three parts: **head**, **core** and **thread** (helix) (Fig. 4.1). The thread is wrapped around the core. The

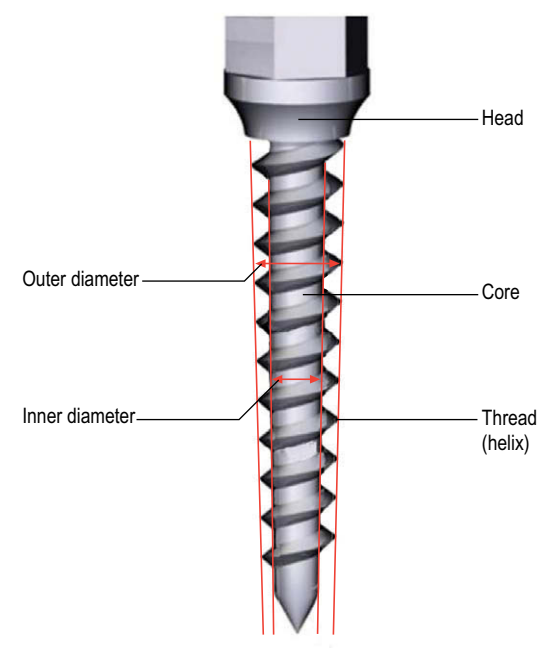


Fig. 4.1 Parts of a bone screw.

diameter of the screw is measured either at the core proper (inner diameter), which does not include the thread, or including the thread (outer diameter). The vertical distance between two adjacent screw threads is called the **pitch** of the screw. One complete revolution of the screw will move it either into or out of an object a distance equal to the pitch of the screw.

Until miniscrew implants designed specifically for orthodontic use became available, the titanium miniscrews used to fix bone plates in plastic and reconstructive surgery (Martin®: diameter 1.5/2.0 mm; OsteoMed®: diameter 1.2/1.6 mm) were also used in orthodontics. Nowadays, many orthodontic companies are producing miniscrews, and these are widely used. In this book, the discussion on the structure and use of miniscrews will mostly be in reference to the systems the authors mainly use, that is, OSAS® (Osseodyne Skeletal Anchorage System; Epoch Medical, Seoul, Korea) and ORLUS® (Ortholution, Seoul, Korea).

The orthodontic miniscrew implant that the authors use is fairly typical in being made of titanium $\alpha + \beta$ alloy ASTM (American Society for Testing and Materials) grade 5, the most widely used titanium alloy (Table 4.1). The chemical name of the alloy is Ti-6Al-4V, and as the name indicates, the alloy contains 6% aluminum and 4% vanadium. It has high strength but relatively low ductility.¹

Table 4.1 ASTM Grades of pure titanium and titanium alloy									
Pure titanium					Titanium alloy				
					$\alpha + \beta$ Alloy		α -Alloy		β -Alloy
ASTM grade	1	2	3	4	5		6		7~36
Chemical formula/name					Ti-6Al-4V	Ti-6Al-4V ELI	Ti-5Al-2.5Sn		Ti-10V-2Fe-3Al

Orthodontic miniscrew implant: constituent parts and design features

The orthodontic miniscrew implant differs from the conventional bone screw as it has a **dual head** (Fig. 4.2) – that is, the head has an additional feature designed specifically for use in orthodontic treatment (for tying a ligature wire or elastic chain). The head is also the part that is engaged in the shaft of the hand screwdriver (hand driver) or a rotary instrument. The design of the head varies depending on the manufacturer and may be hexagonal, octagonal or even ball shaped. Between the head and the core is the part that contacts the

gingival soft tissue (**soft tissue interface**) which is often referred to as the neck or collar. Some manufacturers supply miniscrews with a longer neck for use in sites such as the palate or retromolar areas where the overlying gingiva is thicker (Fig. 4.3).

The **core** is designed to maximize stability and aid insertion of the miniscrew into the bone. Its diameter varies from 1.2 mm to 2 mm (this is called **inner diameter** of the screw). However, most manufacturers give the **outer diameter**, which includes the width of the screw threads in the measurement.² The diameter and thread length of the miniscrew are the main

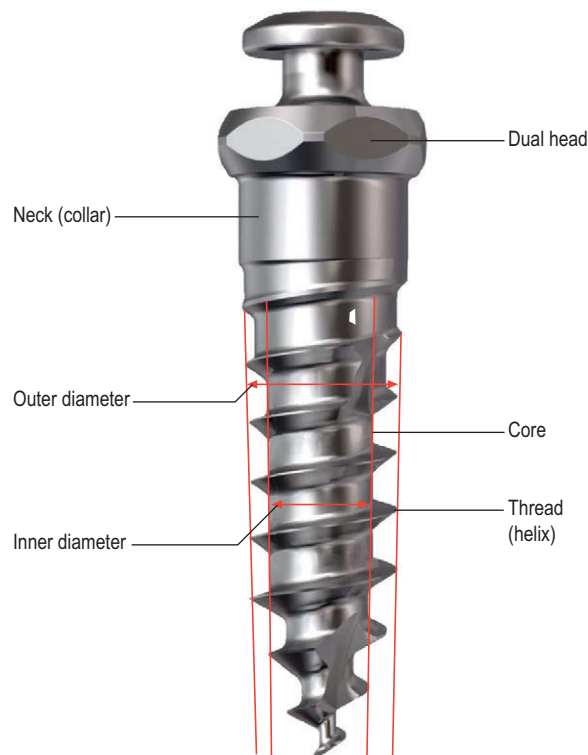


Fig. 4.2 Parts of an orthodontic miniscrew (ORLUS®).



Fig. 4.3 A screw with a long soft tissue interface.

features to consider when selecting a miniscrew (Fig. 4.4). A few orthodontic miniscrew implants require **drilling**, that is, preparing a small hole before insertion (Fig. 4.5). Such miniscrews are referred to as **pre-**

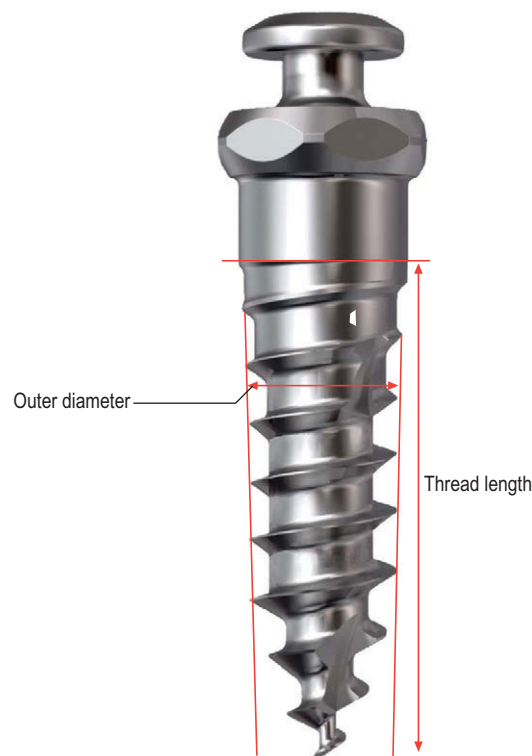


Fig. 4.4 Thread length and outer diameter.

drilling or **drilled** miniscrews. In the OsteoMed® bone screw system, which was more widely used in the past, drilling was required for screws with a diameter of 1.2 mm, but not for screws with a diameter of 1.6 mm or greater. Most of the current orthodontic miniscrew implants are of the **drill-free** or **self-drilling** type (Fig. 4.6) and have a diameter of 1.6 mm. These drill-free miniscrews have a specially formed cutting flute that allows insertion without drilling. At the tip of the core, there is a vertical **groove** that prevents clogging of bone debris during insertion (Fig. 4.7).

Threading the fixture site is referred to as **tapping**. Both the pre-drilling and self-drilling orthodontic miniscrew implants do not require a separate tapping procedure, as the miniscrew thread is designed to tap the bone during insertion. Hence, all orthodontic miniscrew implants are **self-tapping** and most of them are **self-drilling** (Fig. 4.8, Table 4.2).

Studies indicate that drill-free miniscrews provide extensive implant–bone contact, with little bone debris and less thermal damage than pre-drilling screws.^{3,4} Drill-free screws presented less mobility when tested with a Periostat (Siemens AG, Bensheim, Germany) with greater bone remodeling and osseointegration

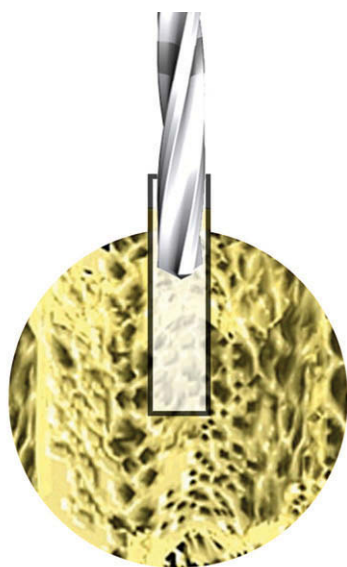


Fig. 4.5 A pre-drilling drill bit.

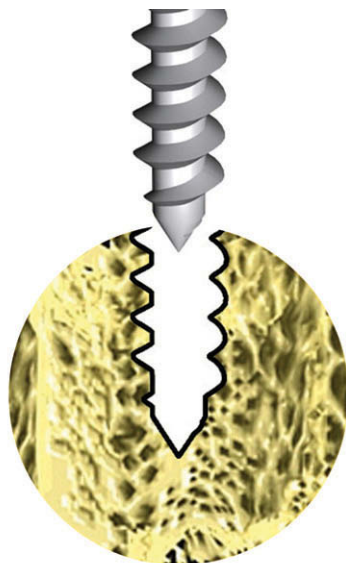


Fig. 4.6 Self-tapping miniscrew and the thread pattern it produces in bone.



Fig. 4.7 Groove at the tip of a drill-free miniscrew.

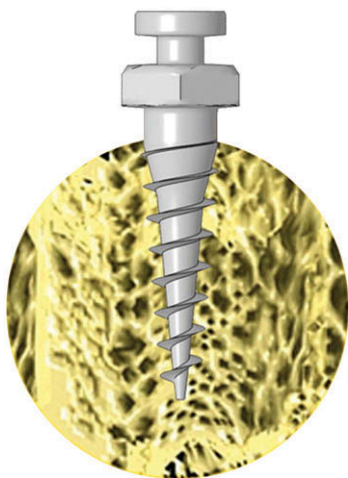


Fig. 4.8 Self-drilling, self-tapping miniscrew.

compared with the pre-drilling screw.⁵ The commonly used 1.6 mm diameter miniscrew is considered to have sufficient rigidity to be inserted without drilling. In the past, when only bone screws were available, miniscrews with a diameter of less than 1.5 mm were inserted using the pre-drilling method to avoid screw fracture. Recent improvement in materials and manufacturing processes have led to the development of self-drilling miniscrews with small diameters of 1.2–1.4 mm (Dentos, Taegu, Korea and Miangang, Seoul, Korea).

The drill-free miniscrews come in a variety of thread lengths (5–9 mm) (Fig. 4.9). They are available in two configurations: **cylindrical** with a diameter of 1.6 mm (OSAS®) and **tapered** with a maximum diameter of 1.6 mm or 1.8 mm (ORLUS®). Some manufacturers supply longer length screws (≥ 11 mm). However, screws of this length are seldom used for the applications shown in this book. The length to be used depends on the thickness of both the soft tissue and the cortical bone at the site of placement. In the midpalatal area, thin soft tissue covers dense cortical bone and its thickness cannot be measured on conventional radiographs. Thus in this area, use of shorter length screws (5 mm) is suggested. The contact with the dense bone provides adequate retention, and loose screws are rare. In the buccal alveolar area, the actual bone thickness is not of much concern but the gingival soft tissue tends to be thicker and the cortical bone less dense. Here, to achieve maximum contact with the cortical bone, miniscrews of 6 mm length are usually used. Longer miniscrews (greater than 6 mm) are used in the retromolar pad area (usually ≥ 8 mm) and the palatal alveolar regions (usually ≥ 7 mm), where the gingival tissue is even thicker. Some systems provide the option of screws with a longer neck or collar (see Fig. 4.3).

Table 4.2 Some features of orthodontic miniscrew implants		
Miniscrew diameter		
	<1.5 mm	>1.5 mm
Drilling	Pre-drilling	Self-drilling (drill-free)
Tapping	Self-tapping	Self-tapping
Drill bit used or not	Drill bit always used	Drill bit used for occasional pilot drilling

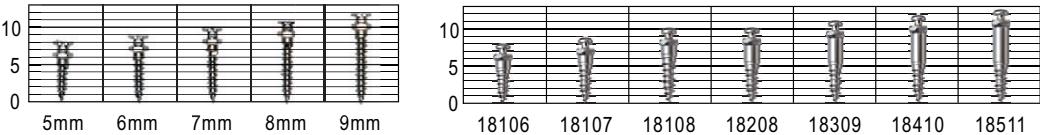


Fig. 4.9 1.6 mm diameter orthodontic miniscrews of different lengths: cylindrical (OSAS®) and tapered (ORLUS®).

Most miniscrews can be placed without any incisions or suturing, as long as the screw will be surrounded by keratinized gingiva. However, if the miniscrew is placed in an area with non-keratinized gingiva, at the borderline between keratinized and non-keratinized gingiva, or if the gingiva is thick, a stab incision is made before placement of the miniscrew. Otherwise, the loose gingival soft tissue will tend to wrap around the miniscrew during the insertion procedure.

ARMAMENTARIUM

Armamentarium for miniscrew placement

Hand instruments:

- Straight hand driver
- Short hand driver
- Contra-angle hand driver (torque driver)

Motor-driven rotary instruments:

- Implant motor with attached handpiece
- Low-speed handpiece with contra-angle head run at a reduced speed (1/128, 1/256 or 1/1024)
- Connecting burs
- Pilot drills

Many of these items listed are only intended or preferred in a minority of situations, and the authors have personal preferences which are discussed below.

Hand instruments

Hand instruments comprise the basic armamentarium required for the placement of orthodontic miniscrew implants. The **straight hand driver** (Fig. 4.10, ORLUS®) has two components, the handle and driver shaft, which are sterilized separately and connected just before the placement procedure. The **short hand driver** (Fig. 4.11, ORLUS®) similarly has a handle and a driver shaft that need to be assembled before use. This driver is used for sites that are difficult to reach with the straight hand driver, such as the midpalatal area. The **surgical**



Fig. 4.10 Straight hand driver: handle and shaft.



Fig. 4.11 A short hand driver, with handle and driver tip.

kit (Fig. 4.12, OSAS®) consists of the instrument organizer with the hand drivers and miniscrews, and optionally, the connecting burs, which are used with a handpiece.

The **contra-angle hand driver (torque driver)** (Figs 4.13, 4.14) may also be used for locations where access with the straight hand driver is difficult, such as the palatal area, retromolar pad and maxillary tuberosity. It looks similar to the motor-driven contra-angle handpiece, but is manually driven. The driver itself is held with one hand while the other hand rotates the wheel at the rear end of the driver. The rotating force is transmitted to the connecting bur and then to the miniscrew. However, manipulation is not as convenient as it was designed to be; it is less precise than the straight hand

driver and force transmission is not as good as with the motor handpiece. In the authors' experience even if the driver is held firmly with one hand, the shaft rotates with the handle when the bone is dense and offers high resistance. Consequently, an undesirable lateral force is transmitted to the miniscrew. Another factor to consider is the inherent defect in the design of the mechanical grip, due to a minute 'gap' between the miniscrew and the connecting bur. The gap causes the rotating miniscrew to 'wobble' during insertion.

Motor-driven rotary instruments

Motor-driven rotary instruments are used mainly for sites that are less accessible, such as the palatal alveolar and midpalatal areas, maxillary tuberosity and retromolar pad area. Care must be taken to use controlled, slow speed and to apply light pressure to the bone when using these instruments, whether for pre-drilling or inserting the miniscrew.

The **implant motor** (Fig. 4.15) is a low-speed, but rather expensive, motor that is usually used in prosthodontic implant procedures. A handpiece is attached to the motor and the rate of rotation is set to 30 rpm or less for miniscrew placement. In physics, *torque* is defined as a measure of a force acting on an object and causing that object to rotate. High torque is a disadvantage – a thin, weak miniscrew may fracture when placed in dense bone.



Fig. 4.12 A surgical kit for orthodontic miniscrew placement.



4.13



4.14

Figs 4.13, 4.14 Figure 4.13 shows the assembled torque driver and Figure 4.14 shows a close-up of the torque driver handle.



Fig. 4.15 An implant motor.

The **low-speed handpiece with contra-angle head** running at a **reduced speed** ($1/128$, $1/256$ or $1/1024$ of the original speed) may be used with the conventional motor attached to the dental unit. To achieve a speed less than 30–60 rpm for miniscrew placement, a handpiece that reduces the original speed to less than $1/256$ should be used. The connecting bur is used to engage the miniscrew and is attached to the handpiece by a mechanical or frictional grip (Figs 4.16, 4.17). The friction grip is more stable than the mechanical grip. As explained earlier, a mechanical grip has some inherent play and causes the miniscrew to wobble during the insertion procedure. The handpiece has quite low torque and the motors stops when high bone resistance is encountered during insertion of the miniscrew. This is an advantage because it prevents breakage of the miniscrew. It is less expensive than the implant motor and is autoclavable.

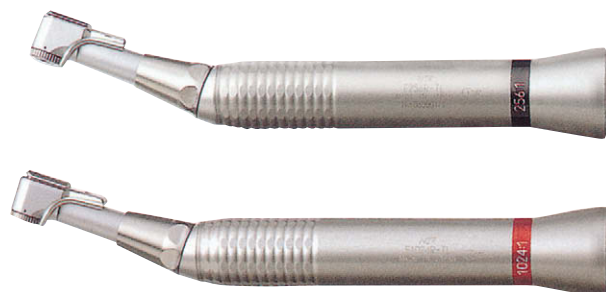


Fig. 4.16 Low-speed handpieces with reduced-speed mechanical grip (NSK RTL series, Nakanishi Inc, Tochigi, Japan).



Fig. 4.17 A low-speed handpiece with reduced-speed friction grip (NSK SPG series, Nakanishi Inc, Tochigi, Japan).

A **connecting bur** (Fig. 4.18) is mounted on a handpiece with a mechanical or frictional grip to connect the handpiece with the miniscrew. These burs come in two lengths (19 mm and 24 mm). Usually the shorter connecting bur is used. The longer bur is convenient when a midpalatal screw is placed in a deep palatal vault.



Fig. 4.18 Connecting burs.

A **pilot drill** (Figs 4.19, 4.20) is sometimes used with a handpiece to drill a hole in the cortical bone before the placement of the miniscrew. The diameter of the hole is smaller than the diameter of the miniscrew. It is used only when a self-drilling miniscrew needs to be inserted in sites with very dense bone and hence a degree of difficulty is anticipated, for example in some patients in the midpalatal, mandibular alveolar or retromolar pad area.

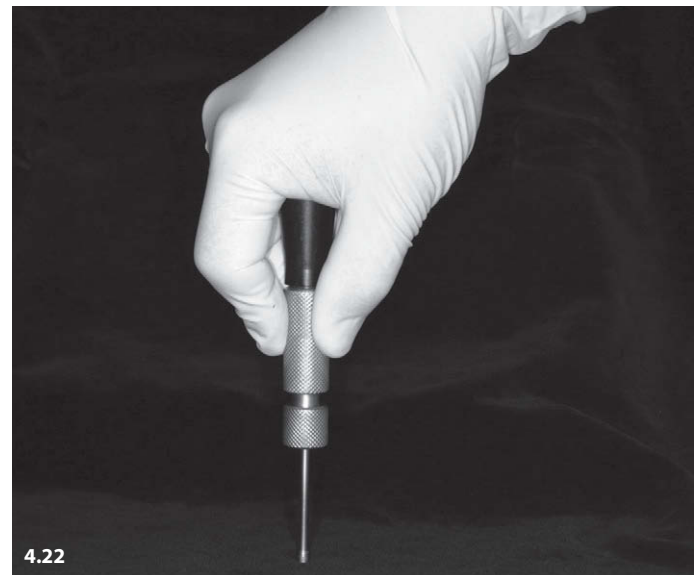


Figs 4.19, 4.20 Pilot drill (Fig. 4.19) hand drill and (Fig. 4.20) connecting bur. Diameter 1.05 mm (both figures).

Useful tips

Gripping the straight hand driver

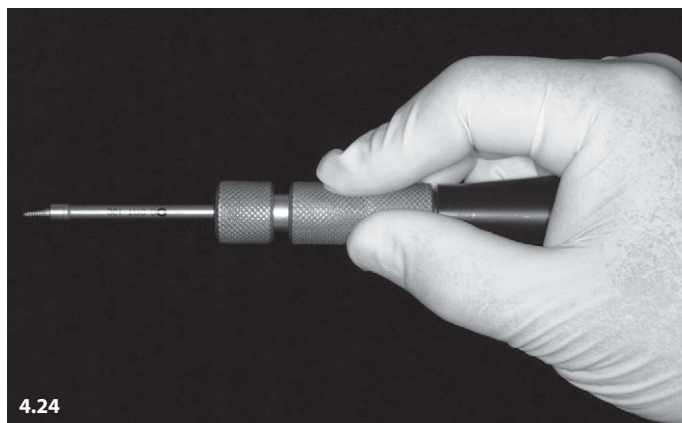
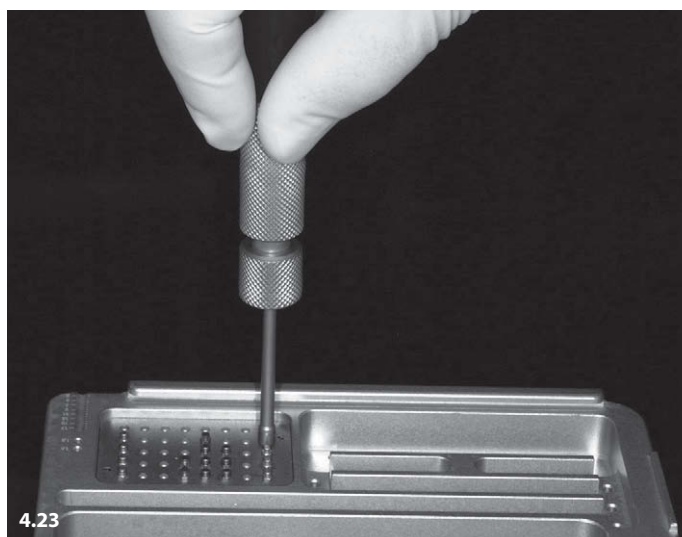
Holding the handle with the palm and the fingers provides a stable grip on the driver and prevents the miniscrew from wobbling around its axis (Figs 4.21, 4.22). The hand driver is rotated slowly at a speed of 15–30 rpm to minimize damage to the cortical bone.



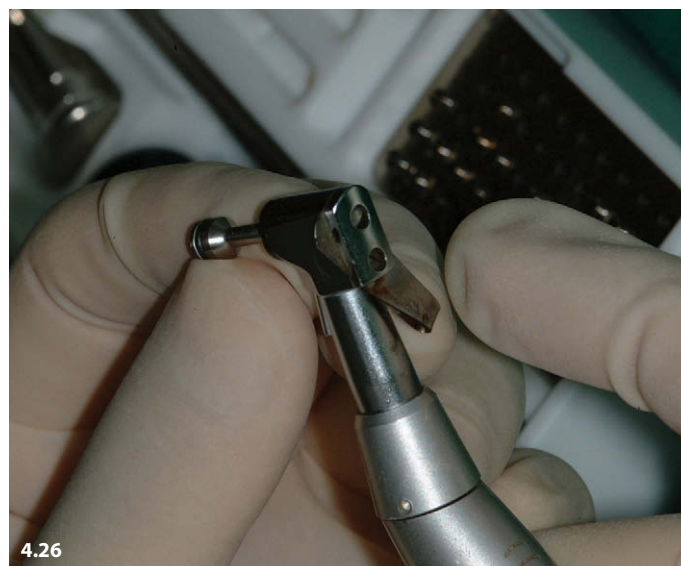
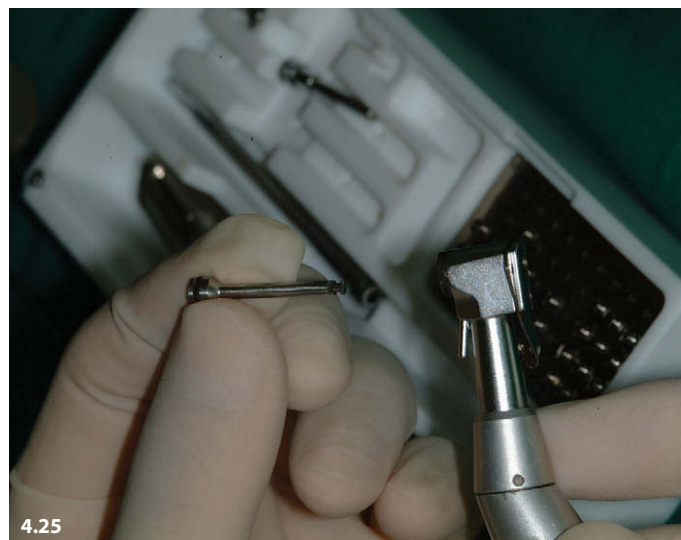
Figs 4.21, 4.22 Correct way to grip a hand driver.

Miniscrew pick-up

When mounting a miniscrew on the tip of the shaft of the hand driver (Figs 4.23, 4.24) or on the connecting bur of a handpiece (Fig. 4.25–4.27), the core of the miniscrew should not come in contact with anything other than sterilized instruments. The miniscrew should be picked up directly from the instrument organizer tray, and the fit between the miniscrew head and the shaft tip or connecting bur should be checked.



Figs 4.23, 4.24 Picking up a miniscrew with a hand driver.



Figs 4.25–4.27 Picking up a miniscrew with a handpiece.

Sterilization protocol

During miniscrew placement, meticulous attention should be paid to sterilization protocols as is required in any oral surgical procedure. Prior to the placement procedure, conventional sterilization protocols should be followed to disinfect the dental unit and chair and its attachments, and the table on which the instruments for miniscrew placement will be placed.

The instruments needed for miniscrew placement are autoclaved. Each instrument is packed separately, for example contra-angle drivers and connecting burs. The instrument organizer is wrapped separately with surgical drapes and then dry heat autoclave. The straight hand driver and the miniscrews should be placed in the organizer. Put a sterilized drape over the bracket table before setting the instruments.

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ANATOMIC CONSIDERATIONS AND PLACEMENT/REMOVAL OF ORTHODONTIC MINISCREW IMPLANTS

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INTRODUCTION

The anatomy of the intended site of placement influences the selection of the miniscrew in terms of its dimensions, location and orientation. This chapter discusses the general anatomic considerations and describes the procedures for placing and removing orthodontic miniscrew implants in commonly used intraoral sites: the buccal/palatal alveolar area, midpalatal region, maxillary tuberosity and retromolar pad area.

ANATOMIC CONSIDERATIONS

Factors that need to be considered during placement of miniscrew implants

- Anatomic structures in the vicinity of the site of placement
- Bone quality
- Soft tissue thickness
- Patient comfort

Anatomic structures in the vicinity of the site of placement

During placement of a miniscrew, the roots of the teeth, nerves and blood vessels, the bone and sinuses in the vicinity of the intended site of placement are all vulnerable to perforation. Particular care needs to be taken when considering placing implants in the buccal and lingual alveolar bone and the paramedian areas of the palate. In contrast, there are no critical anatomic structures in the midpalatal region, the maxillary tuberosity and the retromolar pad area, except for the incisive canal in the palate.

Maxilla

In the maxilla, the commonly used sites for miniscrew placement are the buccal/palatal alveolar area, the midpalatal region and the maxillary tuberosity. The anatomic structures that need to be considered are:

- tooth roots
- greater palatine neurovascular bundle
- nasal cavity
- maxillary sinus.

Tooth roots

When planning to insert a miniscrew between tooth roots, a panoramic radiograph should be used to select the site of placement. This will ensure there is sufficient inter-radicular space at the chosen site. The inter-radicular space is greater between tooth roots that diverge from each other. In the maxilla, the inter-radicular space between the roots of the second premolar and first molar tends to be greater than that between the roots of the first and second molars at a level of 5–7 mm apical to the alveolar crest.¹

Due to the conical shape of tooth roots, the inter-radicular space increases toward the apical area. Theoretically, the more apically the miniscrew is placed, the less is the risk of root damage. However, this is limited by the width of attached gingiva and the depth of the buccal vestibule, as well as mechanical factors. In the authors' experience, in most patients, cylindrical or tapered miniscrews with a diameter of 1.6 mm can be placed at the level of the junction between the cervical and middle thirds of the root.

Generally it is preferable to insert a miniscrew after leveling and aligning of the teeth is complete with a full-size rectangular archwire in place. This way the roots are aligned and the optimal site of placement can be determined with a panoramic radiograph, which helps to avoid root damage (Fig. 5.1). Some loss of molar anchorage loss is inevitable during the alignment phase of treatment. Depending on the amount of initial crowding, the timing of miniscrew placement in the upper and lower arches may vary. The timing of miniscrew placement is also different for patients who need miniscrew anchorage from the beginning of the initial phase of the treatment. For example, a miniscrew may be used as anchorage to prevent proclination of lower incisors during the leveling and aligning stage of non-extraction treatment in a patient



Fig. 5.1 Placing miniscrew implants after completion of leveling.

with Class III malocclusion with lower crowding. In such cases, distal traction force is applied between the molars and miniscrews (see Chapter 6, Case 6.4) placed in the buccal alveolar bone or in the retromolar pad area. The molars should be well aligned though and the miniscrew should be placed with vertical orientation to minimize root contact. Miniscrew anchorage can also be used early in the treatment to apply a light retraction force to a mesially angulated canine in an extraction case. It is important to keep a check on the root proximity of the miniscrew, as teeth are still moving when a miniscrew is placed before alignment is complete.

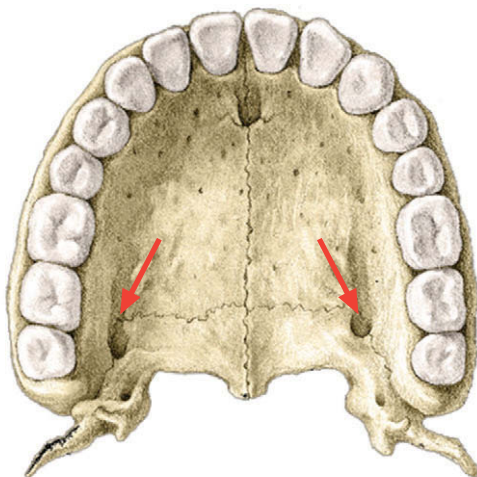


Fig. 5.2 The greater palatine foramina are located in the posterior palate.

Greater palatine neurovascular bundle

The greater palatine neurovascular bundle consists of a nerve, artery and vein that enter the oral cavity through the greater palatine foramen (Figs 5.2, 5.3),

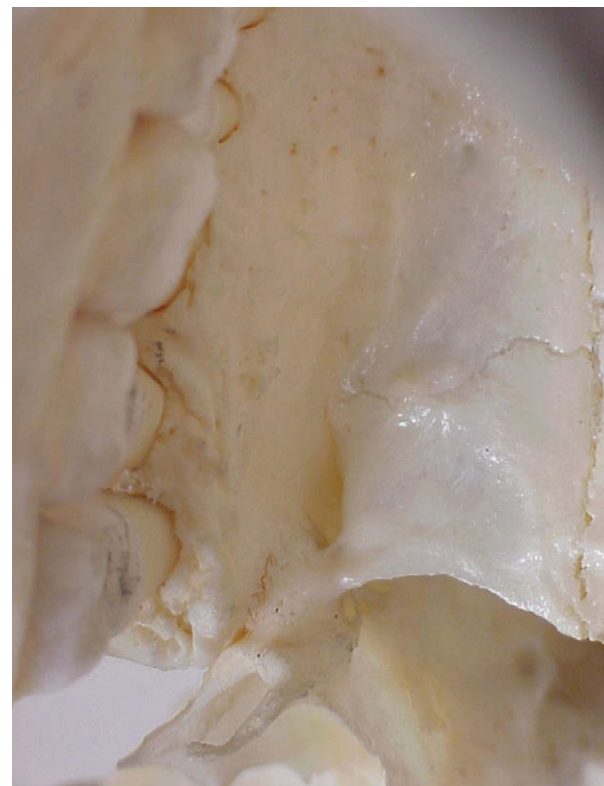


Fig. 5.3 The greater palatine neurovascular bundle is found in the corner of the palatal vault.

at the junction between the palatine process of the maxillary bone and the oral surface of the palatine bone. The two greater palatine foramina are typically located medial to the third molars. The bluish color of the vein and softer texture of the gingiva in this region provide clues to the location of the neurovascular bundle in the corner of the palatal vault.

The greater palatine neurovascular bundle must be taken into consideration when inserting a palatal alveolar miniscrew. The average distances of each component of the bundle from the midpoint between the cemento-enamel junctions of two adjacent maxillary posterior teeth are:²

- artery – 12.7 mm (between the first and second premolars); 11.8 mm (between the second premolar and first molar); and 13.4 mm (between the first and second molars)
- nerve – 15 mm (between the first and second premolars); 14 mm (between the second premolar and first molar); and 15 mm (between the first and second molars).

The nerve tends to be located more medial to the artery and the vein lies between the nerve and the artery.² These distances are average values and placing palatal alveolar miniscrews within 10 mm from the cemento-enamel junction reduces the risk of damaging the greater palatine neurovascular bundle.

Nasal cavity

The midpalatal suture, the region with the thickest cortical bone in the palate, is one of the most suitable sites for miniscrew placement in adults. There is no critical anatomic structure to avoid in this area. The vomer lies superior to the suture (Fig. 5.4). The nasal crest is triangular in shape with a width of 5.4 mm at its base and a height of 5.6 mm in the average adult, which is sufficient for miniscrew placement.³ The nasal crest between the anterior and posterior nasal spines (ANS and PNS) has been reported to be at least 2 mm thicker than it appears on a lateral cephalogram.⁴ Therefore, in most patients, the bone in this region is

thick enough to place a miniscrew with a diameter of 1.6 mm and length of 5 mm.

However, miniscrew placement in the midpalatal suture area should be avoided in growing children. This is because ossification of the suture is incomplete before the age of 23 years.⁵ In patients younger than 20 years the paramedian area of the palate is a more favorable site for miniscrew placement rather than along the suture. As the bone thickness in this region is limited the nasal cavity may be perforated if the miniscrew used is too long. Bone in the area 1 mm lateral to the midpalatal suture line is thickest in the posterior palate. However, not all patients have bone height greater than 4 mm. The palatal bone thickness decreases laterally, so the paramedian miniscrew should be placed quite close to the midpalatal suture, and it should be shorter in length to avoid perforating the nasal cavity and compromising stability.⁶

Maxillary sinus

The stability of a buccal alveolar miniscrew is compromised when the floor of the maxillary sinus extends inferiorly to the alveolar bone between the maxillary posterior teeth. Although minimal complications have been reported following maxillary sinus perforation during orthodontic screw placement,⁷ it may be wise to avoid this area in patients with marked pneumatization (Fig. 5.5).

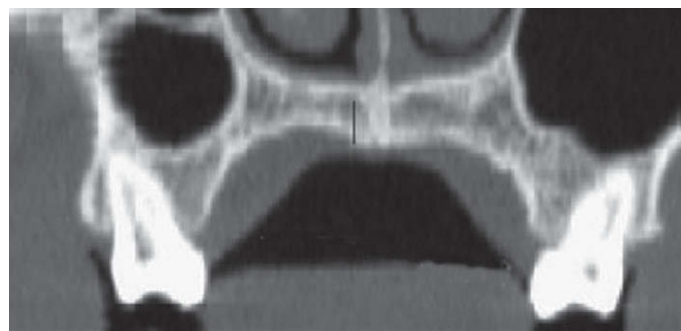


Fig. 5.4 The midpalatal suture is composed of thick cortical bone, and the vomer is in contact with its nasal surface. (Reproduced with kind permission of Department of Orthodontics, College of Dentistry, Yonsei University, Seoul, Korea.)

Mandible

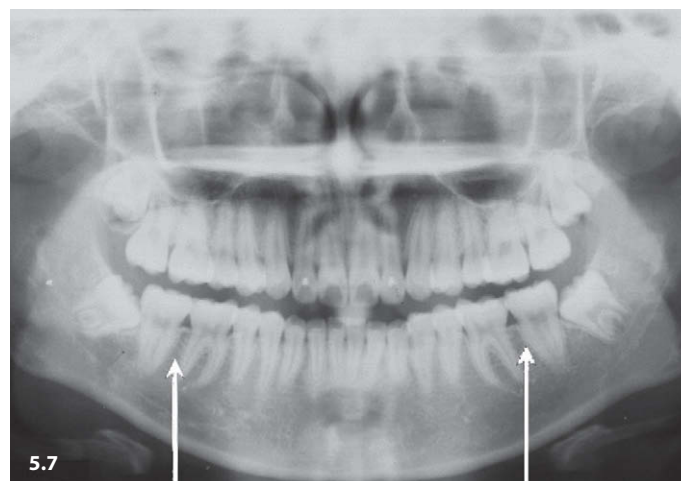
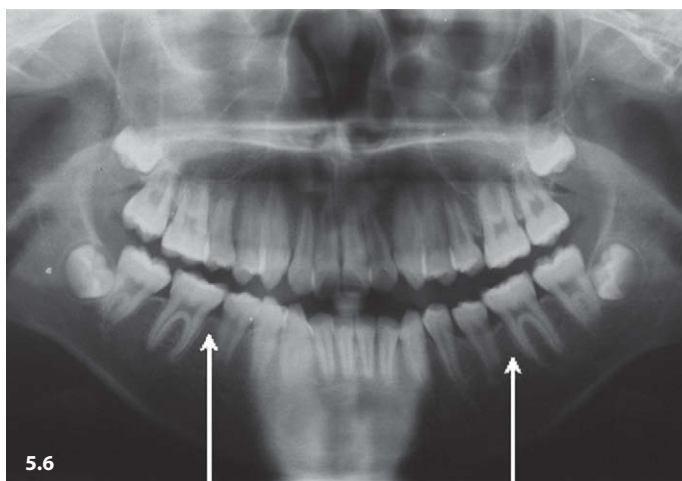
The mandible is a relatively risk-free area for miniscrew placement. The common sites used in the mandible are the labial and buccal alveolar and retromolar pad areas. The anatomic structures that need to be considered are mainly the tooth roots. All the other important mandibular structures – the mandibular canals, mental foramina, buccal and lingual nerves – are located at a distance so there is little risk of damage during routine miniscrew placement.

Tooth roots

As in the maxilla, insertion of the labial and buccal alveolar miniscrew in the mandible may damage tooth roots. When selecting the site for placement, the panoramic radiograph must always be checked for available space (Figs 5.6, 5.7). Again, inter-radicular space increases towards the apical thirds of the roots and the risk of damage to the roots during placement procedure decreases. In the authors' experience, a cylindrical or tapered miniscrew with a diameter of 1.6 mm can be easily placed at the level of the junction between the cervical and middle thirds of the roots in most patients. In the mandible, the inter-radicular distance is the greatest between the first and second molars, 5–7 mm apical to the alveolar crest.¹



Fig. 5.5 A patient with marked pneumatization of the maxillary sinuses is a poor candidate for miniscrew implant placement in the buccal alveolar bone.



Figs 5.6, 5.7 Checking the panoramic radiograph for sufficient space for miniscrew placement in the mandible. Figure 5.7 shows converging molar roots.

Bone quality

The stability of miniscrew implants depends on the quality and quantity of the cortical bone. In dense, thick cortical bone, adequate retention can be achieved with lesser depth of penetration by the miniscrew. However, the thickness and density of the bone varies between different anatomic sites in the same patient and between patients.

According to the Misch classification,⁸ the maxillary alveolar bone is mostly composed of porous bone, corresponding to D3 or D4, whereas the mandible has dense bone classified as D2 and D3. The anterior area tends to have denser bone than posterior areas.

The thickness of alveolar cortical bone differs in different parts of the jaws. The maxillary cortical bone is thicker in the palate than on the buccal surface.^{2,9} The maxillary buccal cortical bone between the first and second molars is thinner than that between the first and second premolars and that between the second premolar and first molar. The palatal cortical bone thickness at 4 mm or more apical to the cemento-enamel junction is uniform throughout (Fig.

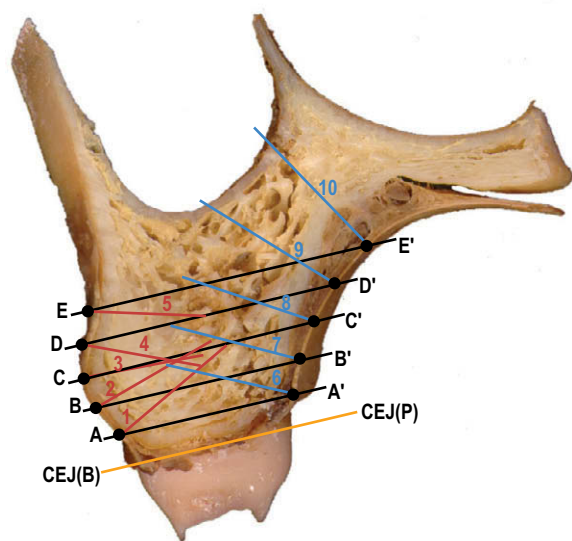


Fig. 5.8 Cross-section of the maxillary bone showing the thickness of the buccal and palatal cortical bone at different levels from the cemento-enamel junction.

The Misch classification of bone density⁸

- D1 – Dense compact bone
- D2 – Dense to thick porous compact bone on the outside and coarse trabecular bone on the inside
- D3 – Porous compact and fine trabecular bone
- D4 – Fine trabecular bone
- D5 – Immature, non-mineralized bone

5.8).^{2,9} In contrast, the mean cortical thickness of the mandibular buccal alveolar bone increases towards the ramus (Fig. 5.9).¹⁰

The midpalatal region is composed of cortical bone of good quality with sufficient volume for placement of a miniscrew (Fig. 5.10). The bone in this area is quite dense and adequate stability of a miniscrew can be obtained with a relatively shorter length miniscrew. The retromolar pad area in the mandible is also composed of dense cortical bone. Due to the hard surface of the bone in this area, drilling is done as necessary prior to placement of a miniscrew in this region. A miniscrew as short as 4 mm embedded in the bone in this area is

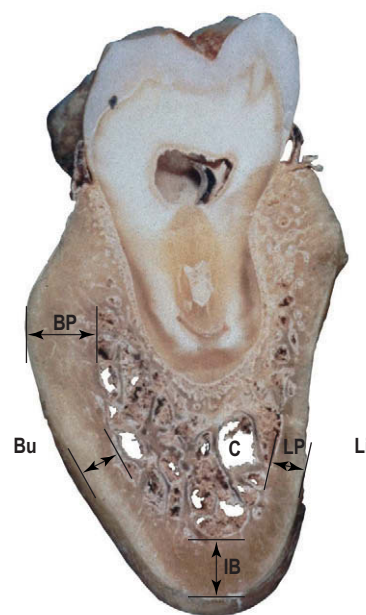


Fig. 5.9 The mandibular buccal bone thickness tends to increase toward the ramus. Bu, buccal; Li, lingual; BP, buccal plate; LP, lingual plate; C, cancellous bone; IB, inferior border.



Fig. 5.10 The midpalatal region is composed of dense cortical bone with sufficient volume for miniscrew implant placement.

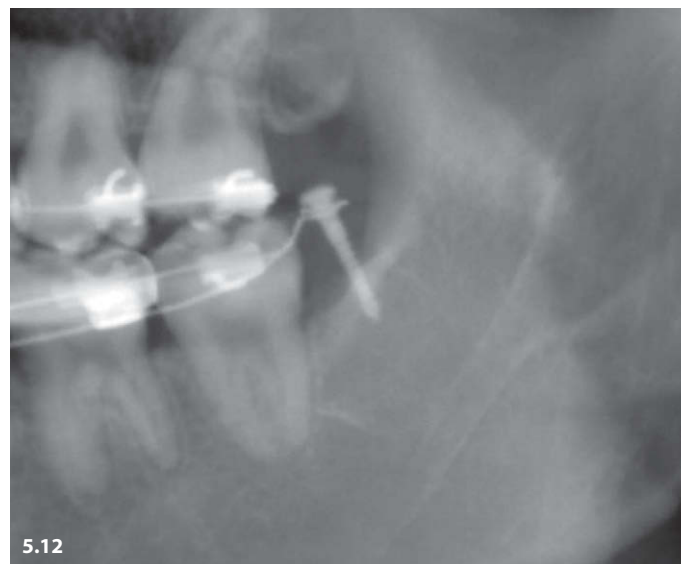
stable enough to withstand orthodontic forces. When using a longer length miniscrew, it is unnecessary to embed the threaded part of the miniscrew fully into the retromolar bone. The threaded part is partly inserted in the bone and in this way the miniscrew head is sometimes accessible in the oral cavity (Figs 5.11, 5.12).



Soft tissue thickness

The soft tissue thickness must also be taken into account when determining the length of miniscrew to be used. The soft tissue covering the palatal slopes is thicker than that in the maxillary buccal alveolar area.^{2,9} In the palate, soft tissue thickness is greater between the first and second molars than between the premolars and between the second premolar and first molar. Soft tissue thickness increases gradually from the cementoenamel junction toward the apical region.^{2,9}

The midpalatal region has excellent soft tissue characteristics for miniscrew placement, as with bone quality. The thin, keratinized soft tissue in this area is more favorable for miniscrew placement than the thick soft tissue on the palatal slopes. Along the midpalatal suture, the mucosa is thickest at the area 4 mm distal to the incisive papilla, and the rest of the posterior area has a uniform soft tissue thickness of 1 mm.^{2,9}



Figs 5.11, 5.12 Open-pull force being applied from a retromolar miniscrew.

The retromolar pad is covered with thick keratinized gingiva, and an incision is required before placement of the miniscrew. The miniscrew head may be embedded in the soft tissue (closed-pull method) or lie exposed in the oral cavity (open-pull method; see next section for details). A miniscrew with a longer soft tissue interface or 'neck' is useful for this purpose (Fig. 5.13).

Patient comfort

Patients rarely complain of pain after routine miniscrew placement. The placement procedure itself causes little or no discomfort. If there is any discomfort it typically lasts for a day or two at most. However, the protruding miniscrew head or the orthodontic attachments (e.g. elastic chain) on it can cause discomfort. Soft tissue irritation is noted in

patients with a shallow buccal vestibule or in areas with little attached gingiva. Another potentially uncomfortable situation is during space closure using sliding mechanics. The elastomeric module, such as an elastic ligature, may impinge on the gingiva in the more prominent part of the arch (Fig. 5.14). This happens more often when the miniscrew is inserted in the more posterior part of the arch, between the first and second molars than between the second premolar and first molar. A 'guidewire' added on the archwire by soldering or welding a long hook can cause the arch to collapse linguallly, and the occlusion may be inadvertently affected with a tendency toward posterior crossbite. (See Chapter 6 for clinical tips to avoid such problems.) Such problems do not usually occur with palatal alveolar miniscrews; most patients tolerate the palatal miniscrew and appliances quite well.



Fig. 5.13 A miniscrew implant with a long neck (soft tissue interface).

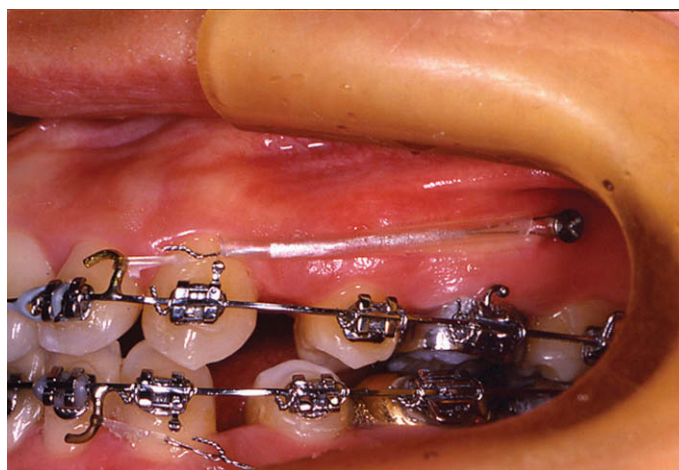
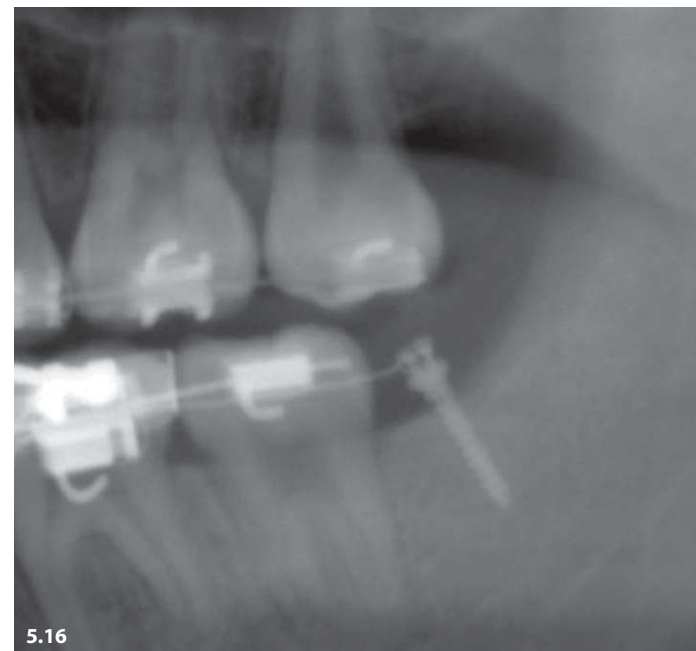


Fig. 5.14 During space closure using sliding mechanics, the elastomeric modules may impinge on the gingiva.

As mentioned in the previous section, when using a retromolar pad miniscrew, its head could be exposed in the oral cavity (**open-pull** method; Figs 5.11, 5.12). This method offers superior patient comfort than the **closed-pull** method, in which the miniscrew is embedded in the soft tissue and a braided wire extension exits through the gingiva (Figs 5.15, 5.16). This often irritates the mucosa.



Figs 5.15, 5.16 Closed-pull force being applied from the retromolar miniscrew.

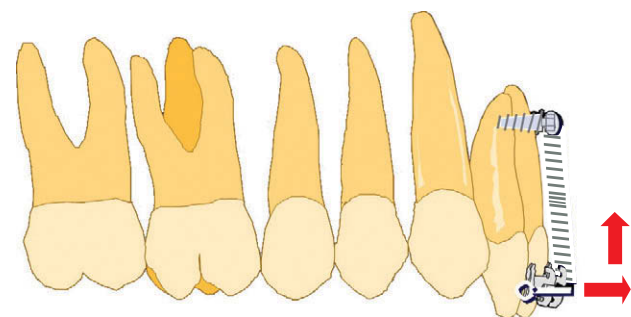


Fig. 5.17 Intrusion of incisors using a miniscrew placed inferior to the anterior nasal spine.

MINISCREW IMPLANT PLACEMENT AND REMOVAL

Once a decision has been made to use miniscrew implants during orthodontic treatment, informed consent should be obtained from the patient. A full explanation is given to the patient about the benefits and side effects of having miniscrews incorporated in the treatment procedure. A potential side effect is loosening of the miniscrew. Mobility can be noted by the patient during brushing or by the orthodontist during the monthly checkup. Generally orthodontists themselves can place drill-free miniscrews without difficulty. However, the patient is referred to an oral surgeon when it is planned to have miniscrews in the retromolar area, which often requires a more invasive procedure. It is important to describe the miniscrew location, possibly by marking on a study model, when referring the patient.

Sterilization and preparation for placement procedure

1. The patient is instructed to rinse with a chlorhexidine solution.
2. Wipe the patient's mouth area with an oral disinfectant. The authors use a disinfectant with hypochlorous acid (30 ppm) as the active substance. Chlorhexidine may also be used.
3. Place a sterile drape over the patient's face to isolate the field.
4. Wipe the recipient area with an oral disinfectant (Fig. 5.18).
5. Apply a topical anesthetic gel.
6. Infiltrative anesthesia is given with 2% lidocaine with epinephrine 1:50 000. Usually injection of a quarter of a single 1.8 mL ampule is sufficient for alveolar miniscrew placement. The small amount of local anesthetic will probably not completely anesthetize the periodontal ligaments so the patient will feel discomfort if the miniscrew touches a root. A buccal alveolar miniscrew requires buccal anesthesia only, and the palatal alveolar miniscrew requires palatal anesthesia only.

Miniscrew placement: general principles

After the placement site is anesthetized, a sterile miniscrew is inserted into the preparation site, observing the following principles of placement.

There are two methods of insertion. The **drill-free** method, in which the screw is placed directly into the cortical bone, is used routinely. In the **pre-drilling** method, a hole is drilled prior to insertion of the screw. When only bone screws were available, drill-free screws had a diameter greater than 1.5 mm. When using screws with 1.2 mm diameter, pre-drilling was done prior to placement of the screw.^{11,12} As explained in Chapter 4, drill-free miniscrews with a smaller diameter of 1.2–1.4 mm with additional features for orthodontic use are now available on the market. These have improved access to narrow inter-radicular bone. Moreover, bone–screw contact with drill-free screws has been shown to be superior to that with pre-drilled screws.¹³ A recent study comparing drilled and drill-free miniscrews (diameter 1.6 mm) found that the drill-free group showed less mobility and more bone-to-metal contact.¹⁴ In addition, the heat generated during drilling can compromise bone regeneration and thus jeopardize implant stability.¹⁵



Fig. 5.18 Wiping the mouth and mucosa with an oral disinfectant.

With drill-free method, pilot drilling is sometimes necessary in the bone area that is unusually dense, for example, in the mandibular alveolar bone and retromolar pad area. **Pilot drilling** is different from **pre-drilling**. For pilot drilling, a small round or fissure bur is used to make a dent in the cortical bone surface. This helps to secure initial penetration of the drill-free miniscrew into the bone. In contrast, in pre-drilling, a bur that has smaller diameter than the miniscrew to be inserted is used and drilled to a depth shorter than the thread length of that miniscrew. Drill depth is greater with pre-drilling.

Hand instruments, such as a straight hand driver or short hand driver, and/or motor-driven rotary instruments are used for miniscrew placement, depending on the accessibility of and bone density at the chosen site. The basic principle of placement is that a speed of **less than 30 rpm** should be used at all times to minimize bone damage. Saline irrigation is not needed during the procedure unless the speed used exceeds the recommended value. However, if pilot drilling or pre-drilling is planned, simultaneous cooling of the area with saline irrigation is mandatory.

Alveolar bone

Maxillary and mandibular buccal alveolar bone

The buccal alveolar miniscrew is commonly used as anchorage for anteroposterior control during tooth movement – for example, in patients with severe protrusion in whom maximum anchorage is required. Both the upper and the lower buccal alveolar areas are relatively undemanding sites for miniscrew placement in terms of accessibility, and generally the hand driver is advocated. The patient is told not to open the mouth so wide, so that the corners of the mouth relaxed and lips can be retracted easily. Without sufficient lip

retraction, it is easy to err, with the miniscrew placed obliquely to the cortical surface of the bone and its head tilted mesially. This not only has an adverse effect on its stability but it also increases the risk of damaging the root of the distal tooth. The electrical handpiece is more convenient to use in posterior areas in patients with a small mouth.

The buccal alveolar miniscrew is inserted into the inter-radicular bone. As stated earlier, careful evaluation of the available space on a panoramic or periapical radiograph is essential prior to the placement procedure. Although the safest location in terms of width of inter-radicular space is between the second premolar and the first molar in the maxilla and between the first molar and second molar in the mandible,¹ interindividual variations in root convergence/divergence must be taken into account.

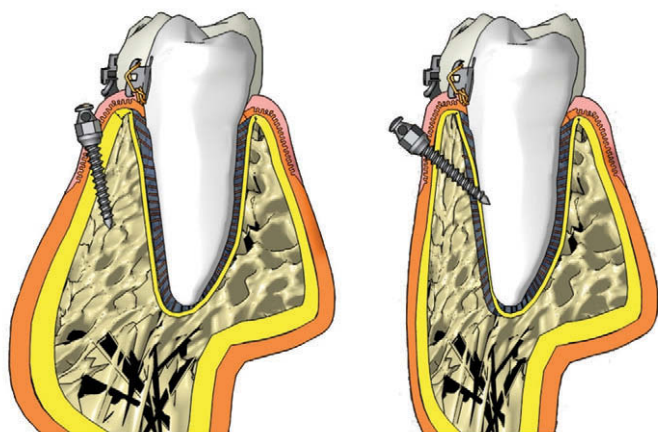
Ideally the miniscrew should be placed in the attached gingiva, which is more resistant to inflammation. However, the width of the attached gingiva is quite narrow in many patients. Hence, it is not always possible to place the miniscrew in the attached gingiva. In such instances, the miniscrew must be placed in the non-keratinized gingiva or at the border between the attached and free gingiva. A vertical **stab incision** is made prior to insertion of the screw to prevent the loose soft tissue of the non-keratinized gingiva from wrapping around the miniscrew. A #12 blade is used for this incision.

Before and during the insertion procedure, the site and direction of insertion should be checked using a mouth mirror to avoid drilling into the neighbouring roots. The miniscrew should be located directly above the contact point of the two adjacent teeth, and it should be perpendicular to the alveolar bone in the occlusal view. Ideally the miniscrew is placed perpendicular to the bone surface. But this is not always advocated. When viewed in the coronal plane, the miniscrew is inserted at an angle to the alveolar bone. When the

buccal alveolar bone volume is sufficient, the miniscrew is placed at a more vertical orientation (Fig. 5.19). Root contact is minimized. If there is a thin covering of alveolar bone, the miniscrew is placed closer to perpendicular to the bone surface. Its mesiodistal placement would be critical to avoid perforating the neighbouring tooth roots (Fig. 5.20).

The patient is instructed to signal if they feel pain during the procedure. Pain does not necessarily mean the miniscrew has penetrated a root because the periodontal ligament is not fully anesthetized and retains some sensation. The operator should also pay attention to their tactile sense, as the density of the tooth root is greater than that of the surrounding bone. When in doubt take a check periapical radiograph after about half of the miniscrew length has penetrated the bone.

After full length placement, a periapical radiograph is taken to verify absence of root–screw contact. A



Figs 5.19, 5.20 The angle of placement of the miniscrew depends on the bone volume.

digital radiograph is recommended for immediate confirmation. Unless root–screw contact is negative, usually two views are taken with the x-ray cone directed at different angles. For example, if the tip of the miniscrew seems to overlap the root of the distal tooth in the first radiograph, a second radiograph is taken from a different angle, with the beam more distal (Fig. 5.21). One image with the tip of the miniscrew located between the roots is enough to verify safe placement (Fig. 5.22).

Palatal alveolar bone

A palatal alveolar miniscrew can be used as anchorage during retraction of maxillary anterior teeth in patients wearing a lingual orthodontic appliance and who need maximum anchorage, or for intrusion of the upper molars. The inter-radicular distance is greater on the palatal side than on the buccal side in the maxillary arch, but the thicker soft tissue² makes the palatal side a less favorable location. Soft tissue thickness is assessed with a sharp instrument such as a probe. A #15 blade is used and through the gingiva up to the bone surface. A #12 blade, which is used for making a stab incision in the buccal alveolar mucosa, is not recommended, because it cuts into the thick palatal mucosa and causes too much bleeding. Taking the soft tissue thickness into consideration, a miniscrew with a longer neck may be used (see Fig. 5.13). The motor-driven instrument should be used, as access with a straight hand driver is difficult. The miniscrew is placed between the palatal roots.

See the section on Anatomic considerations for a detailed discussion of structures to avoid in this area.

Figs 5.21, 5.22 In Figure 5.21 the miniscrew seems to be impinging on the root of the second molar. A second radiograph taken with the x-ray beam directed more distally shows the miniscrew is located between the roots (Fig. 5.22).



Placement procedure

Maxillary buccal alveolar area – using straight hand driver

1. Determine the site before insertion by placing a probe parallel to the long axis of the teeth and keeping in mind the position of the tip of the miniscrew (Fig. 5.23). For the buccal alveolar miniscrew, the site of insertion is occlusal to the final position of the tip of the miniscrew. Appropriate height is determined by viewing the panoramic radiograph and an effort is made to place the miniscrew in the attached gingiva.
2. A pinpoint mark is made at the planned insertion site with an explorer (Fig. 5.24). This is checked with a mouth mirror. If the miniscrew is to be placed in non-keratinized, unattached gingiva, such as in the posterior buccal alveolar region, where there is little attached gingiva, an additional step is required at this stage. A vertical stab incision up to the bone surface is made in the gingiva with #12 blade to prevent wrapping of the soft tissue around the miniscrew. Gingival undermining is not necessary.
3. The miniscrew is mounted on a hand driver and secured on the cortical bone surface, before driving through the bone (Fig. 5.25). The patient should be instructed not to open the mouth too wide, so that lips are relaxed and retraction is readily possible. Check the orientation and location of the miniscrew with the mouth mirror (Fig. 5.26). Looking through a mirror from the occlusal side helps to confirm the miniscrew location. Checking the miniscrew's position with a naked eye from the chairside may lead to errors because the operator's line of view is usually oblique to the placement site, especially in the posterior alveolar area. A miniscrew that seems to penetrate a dental root when checked with the naked eye may actually be well positioned when checked with an x-ray.
4. Drive in the screw by rotating the hand driver clockwise at less than 30 rpm (1/4 rotation per second). No saline irrigation is required, unless the speed exceeds the recommended rate. However, it is possible to exceed this rate even when the miniscrew is manually driven into the bone. Thus the authors routinely use saline irrigation.
5. Stop driving when the head of the screw lies at the level of the surface of the gingiva (Fig. 5.25). Detach the driver from the miniscrew by pulling the driver exactly in line with the axis of the screw.



Figs 5.23–5.27 Placing a miniscrew in the maxillary buccal alveolar area.

Maxillary buccal alveolar area – using a rotary instrument

Rotary instruments may be used for placing miniscrews in the buccal alveolar bone especially in the area between the first and second molars. The procedure is basically the same as that with the hand instrument, except that the handpiece connected to the implant motor or a contra-angle low-speed handpiece run at reduced speed is used to insert the miniscrew. A connecting bur is required to mount the miniscrew on the handpiece.

1. Determine the site and mark the soft tissue at the planned location.
2. Mount the miniscrew on the handpiece (Fig. 5.28). Secure the miniscrew at the insertion site and check the orientation of the miniscrew with the mouth mirror.
3. Drive the screw into the bone using a low-speed handpiece, with light pressure at a speed of less than 30 rpm (Fig. 5.29). No saline irrigation is required, unless the speed exceeds the recommended rate.
5. After placement detach the handpiece from the inserted miniscrew. This may not be easy because owing to the tight contact between the connecting bur and the miniscrew head, and the confined space at the back of the oral cavity. Detach the connecting bur first from the handpiece and then the bur from the miniscrew.

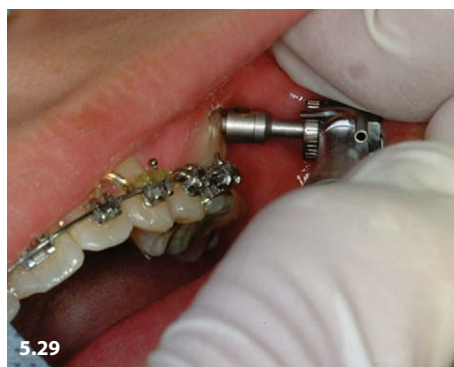
Palatal alveolar bone – using a rotary instrument

1. Determine the site and mark the soft tissue at the planned insertion site.
2. Make a vertical incision through the gingiva to the bone surface using a #15 blade (Fig. 5.30).
3. Mark on the surface of the cortical bone with an explorer. Check with mouth mirror.
4. Insert the screw using a low-speed handpiece, with a light pressure, at a speed of less than 30 rpm (Fig. 5.31). The miniscrew is inserted perpendicular to the bone surface, with the tip directed apical to the head. No saline irrigation is required, unless the speed exceeds the recommended rate.
5. Finish and detach the handpiece from the inserted miniscrew (Fig. 5.32).

Mandibular buccal alveolar area – using a hand driver

The procedure for placing a miniscrew in the mandibular buccal alveolar area is basically the same as that in the maxillary buccal alveolar area. However, a stab incision will be required if the miniscrew is placed in the unattached gingiva (Fig. 5.33). The mandibular cortical bone tends to be more dense than the maxillary alveolar bone, i.e. greater torque may be necessary for miniscrew placement.

The step-by-step procedure of miniscrew placement in the mandibular buccal alveolar area is depicted in Figures 5.34–5.37.



Figs 5.28, 5.29 Using a rotary instrument to place a miniscrew in the maxillary buccal alveolar area.



Figs 5.30–5.32 Placing the miniscrew in the palatal alveolar area.



Fig. 5.33 Making a stab incision prior to miniscrew placement in the mandibular buccal alveolar area.

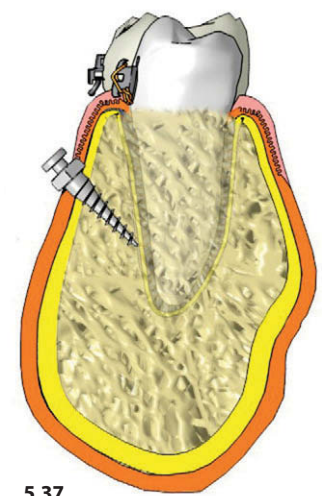
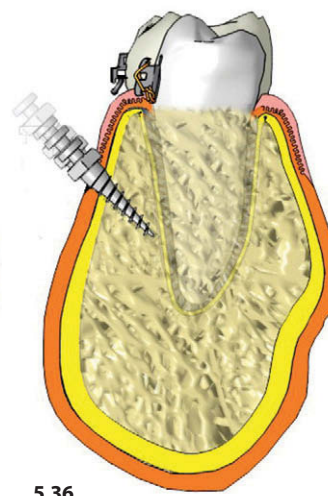
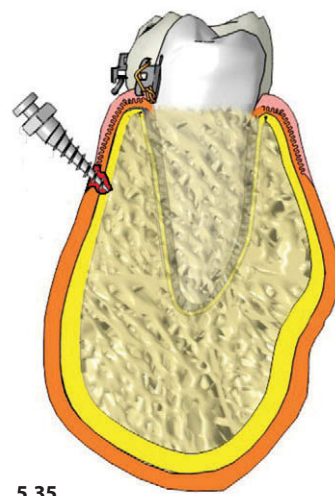
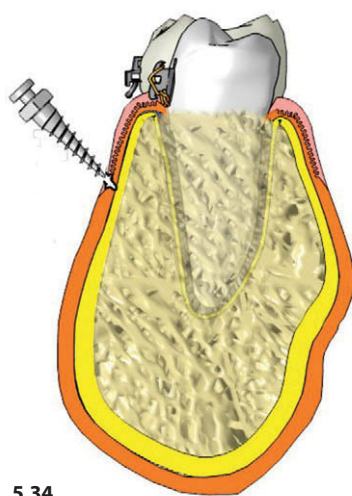


Fig. 5.34–5.37 Step-by-step placement procedure in the mandibular buccal alveolar area. First mark the location on soft tissue and then make a small notch in the cortical bone surface. Drive the screw into the bone. Figure 5.37 shows the placement completed.

Mandibular buccal alveolar area with hard bone surface – pilot drilling and using a hand driver or a rotary instrument

In the mandibular buccal alveolar region, the cortical bone is sometimes quite dense. This can make the initial insertion difficult. The screw tip may slip off the bone surface. Pilot drilling is done to the depth of the cortical bone with a small round or fissure bur. The miniscrew is inserted using a hand driver or a handpiece. This pilot drilling is different from the pre-drilling method advocated by some clinicians for miniscrews with a diameter of 1.2 mm (see above).^{11,12}

1. Determine the site, and mark the soft tissue for placement with a sharp instrument.
2. Pilot drill the cortical bone surface with a fissure bur in a handpiece, with saline irrigation.
3. Insert the miniscrew into the notch created with the fissure bur, using a hand driver or a handpiece.

Kim's stent: a precision technique for accurate positioning of miniscrews between tooth roots (designed by Dr Tae-Woo Kim)

When placing a miniscrew in the buccal alveolar region it is important to avoid touching the neighboring tooth roots. This section describes a method for accurate positioning of a miniscrew in the inter-radicular space using a guidewire called **Kim's stent** (Figs 5.38–5.40).

Kim's stent has two parts. The **direction guide** (Figs 5.38, 5.40: labeled 'D') is engaged in the tooth mesial to the site of miniscrew placement. The occlusal arm determines the *direction* of the miniscrew placement and the direction of the x-ray beam. The **positioning gauge**, which helps determine the final placement site, is engaged in the tooth distal to the site of miniscrew placement (Figs 5.39, 5.40: labeled 'P').

A stone model and a periapical radiograph are used with the stent to determine the direction of miniscrew placement. An impression is taken with the archwire removed, including the vestibular area. The direction of insertion and the site of the placement are marked on the model. The guidewire is made with .021/.028

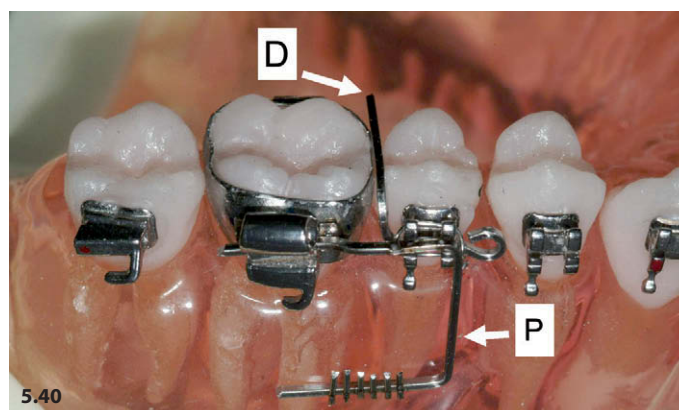
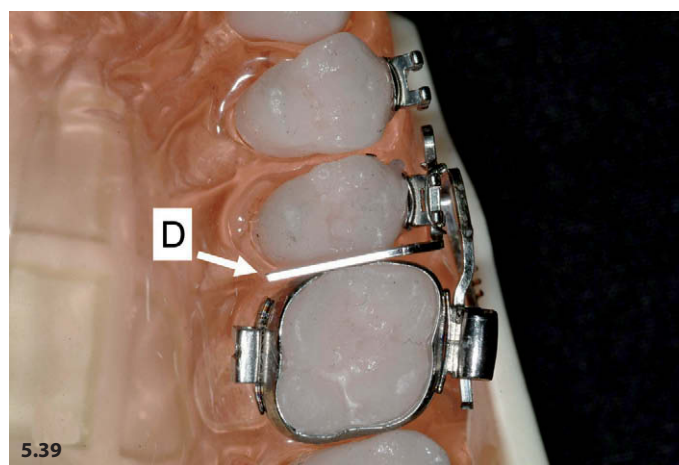
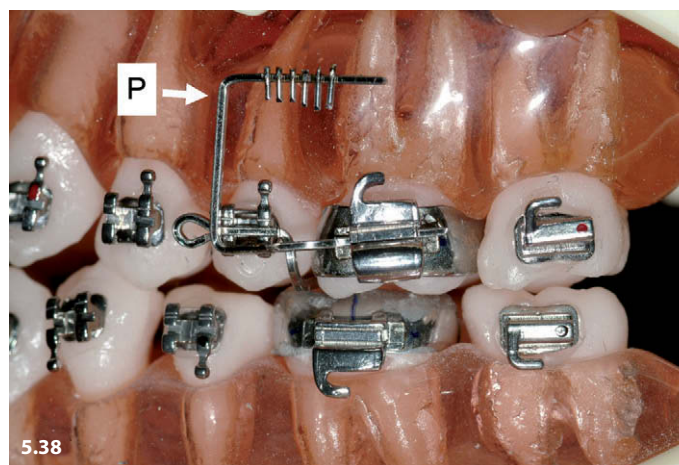


Fig. 5.38–5.40 Kim's stent for miniscrew placement: P, positioning gauge; D, direction guide.

stainless steel wire (JinSung, Seoul, Korea) to minimize play in the .022 slot bracket (MBT™, 3M-Unitek, California, USA) and deformation. Five to seven 3 mm long pieces of .014 Elgiloy wires (Rocky Mountain Orthodontics, Colorado, USA) are welded onto the horizontal arm of the positioning gauge at intervals of 1 mm, to be used as gauges.

After the two parts of the guidewire are engaged in the respective teeth, a periapical radiograph is taken. It is important that the x-ray beam is pointing in the same direction as the occlusal arm of the direction gauge (Fig. 5.41). Only if this has been correctly done will the occlusal arm of the direction guide help the operator to determine the direction of the screw. An accurate radiograph will ensure that the roots are visualized precisely in the direction from which the miniscrew will be placed. A point between two adjacent roots and the corresponding welded wire of the positioning gauge is identified on the radiograph. The final miniscrew site is determined by making anteroposterior adjustments to the predetermined position, so that it is directly occlusal to the chosen welded wire (Fig. 5.42). The miniscrew is placed with the axis of the driver parallel to the axis of the direction guide (Fig. 5.43).

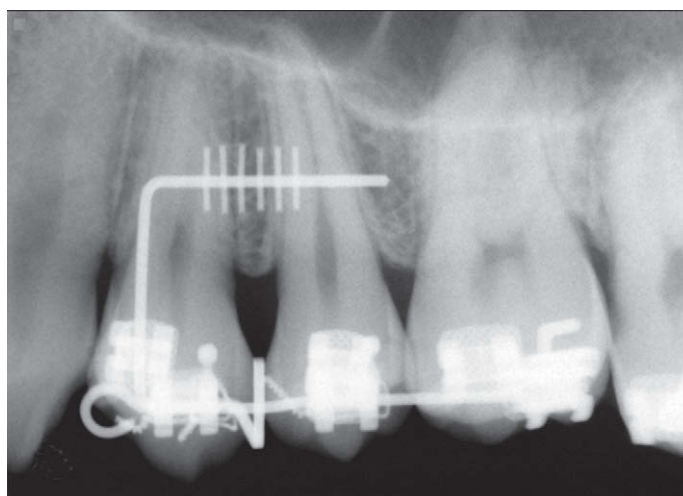
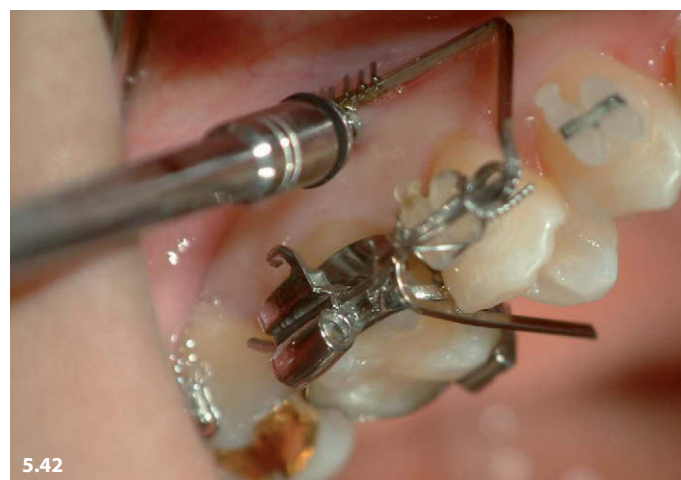


Fig. 5.41 Taking a radiograph with Kim's stent in place. The direction guide extends perpendicular to the occlusal surface parallel to the x-ray beam. The positioning gauge shows that there is about 3 mm of inter-radicular space.

Removing a miniscrew from the buccal alveolar area

The buccal alveolar miniscrew is removed with a hand driver. Topical anesthesia is applied and the patient is asked to rinse their mouth with chlorhexidine. The hand driver is fitted on the miniscrew head and rotated counterclockwise. Anesthesia is not needed for removal because the bone does not have sensory nerve endings.



Figs 5.42, 5.43 Miniscrew being placed with Kim's stent as a guide. A wire segment on the positioning gauge is chosen to determine the anteroposterior position of the miniscrew, using the radiograph as a reference. The miniscrew is placed 2–3 mm occlusal to the horizontal arm. Next, using a mouth mirror to see the occlusal surface, the driver axis is made parallel to the direction guide before the miniscrew is inserted.

Midpalatal region

The midpalatal bone area is an excellent site for miniscrew placement in terms of both soft and hard tissue characteristics. The thin, keratinized soft tissue and high-density cortical bone in the midpalatal area are advantageous for miniscrew implantation and retention.¹⁶

The shortest thread length miniscrew (5 mm) is adequate. Although the nasal crest is present on its dorsal aspect, the bone thickness is limited and cannot be accurately measured on a conventional radiograph. A miniscrew that is too long could penetrate into the nasal cavity. Since the midpalatal region is composed of hard, dense cortical bone, a miniscrew does not have to be embedded too deeply in the bone for adequate stability.

When selecting the connecting bur, the depth of the palatal vault and the angle of placement need to be considered. A deep palatal vault requires a longer connecting bur (24 mm) to avoid collision of the handpiece with the upper incisors during placement. Regarding the direction of placement, the miniscrew should be inserted perpendicular to the roof of the oral cavity. However, in deep palates, the miniscrew may have to be inserted slightly from posterior to anterior direction in the sagittal plane (Fig. 5.44). The miniscrew then may not be perpendicular to the palatal roof, but this slight deviation is actually advantageous. The length of the miniscrew engaged in the bone is greater. This not only improves its retention by increasing the contact between the screw and the bone but also reduces the risk of perforation of the nasal cavity. It is also often easier to engage an elastic module on a miniscrew inserted in this way.

A short hand driver or torque driver may also be used to place a miniscrew in the midpalatal region, but it can be difficult to turn the handle against the highly dense midpalatal cortical bone. Quite often, the force generated manually may not be enough to initiate insertion. Also, if the handpiece is used alone, a transpalatal arch may be in the way. The path may be deflected and cause breakage of the miniscrew.

Usually a **motor-driven handpiece and short hand driver** are used in combination; the handpiece is used in the initial stage of insertion when a high torque, or strong rotating force, is required. After more than half of the threaded part has been inserted into the bone, the short hand driver is used to drive in the rest of the miniscrew. The advantage of using the hand driver is the ability to have tactile sense during insertion. The subtle bone resistance can be detected and miniscrew breakage due to too heavy a rotating force is prevented.

A **torque driver** (BIOMET 3i Florida, USA) is also available, but the authors have not found it convenient to use. As explained in Chapter 3, its precision is inferior to the hand driver and its force transmission is inferior compared with the motor-driven handpiece. Therefore the motor-driven handpiece and/or short hand driver is recommended.

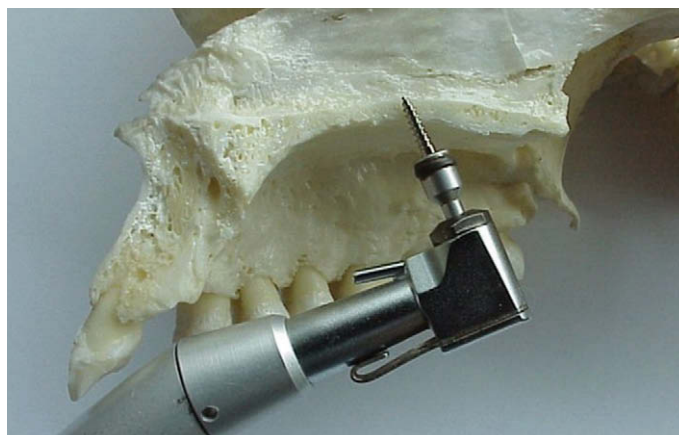


Fig. 5.44 Direction of insertion of the miniscrew in a deep palate (sagittal view).

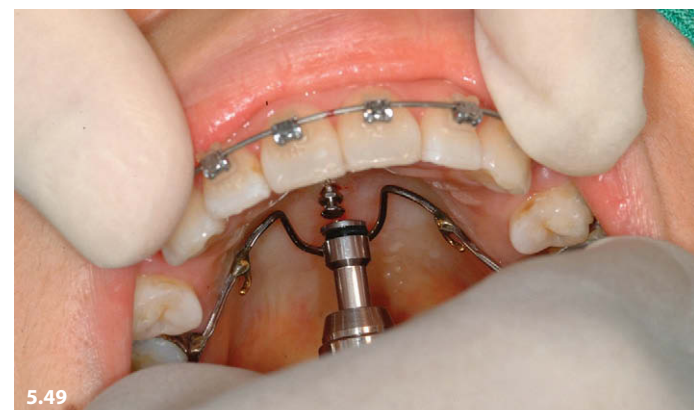
Placement procedure

Rotary and hand instruments, no pilot drilling

1. After anesthesia mark the soft tissue for placement with a sharp instrument.
2. Establish the path of insertion and insert the distal half of miniscrew using a contra-angle low-speed handpiece, applying light pressure (Fig. 5.45).
3. Detach the handpiece from the miniscrew (Fig. 5.46). As described, if it is difficult to detach the handpiece and connecting bur from the miniscrew, disconnect the handpiece from the connecting bur first, and then the connecting bur from the miniscrew head. This two-step separation reduces the jiggling force on the inserted miniscrew.
4. A short hand driver (Fig. 5.47) is then used (Fig. 5.48) to drive in the miniscrew (Fig. 5.49).



Figs 5.45–5.49 Placing a miniscrew in the midpalatal region.



Removing a miniscrew from the midpalatal region

For removing the midpalatal miniscrew, the short hand driver or handpiece is used to grab the miniscrew head and rotated counterclockwise. Local anesthesia is not necessary.

Maxillary tuberosity

The maxillary tuberosity is used for miniscrew placement when the upper molars need to be distalized. The bone quality in this region is relatively poor (Misch D3 or D4 categories), but there are no anatomic structures to avoid. As the soft tissue is thin in this area, a 6–7 mm long miniscrew can be used.

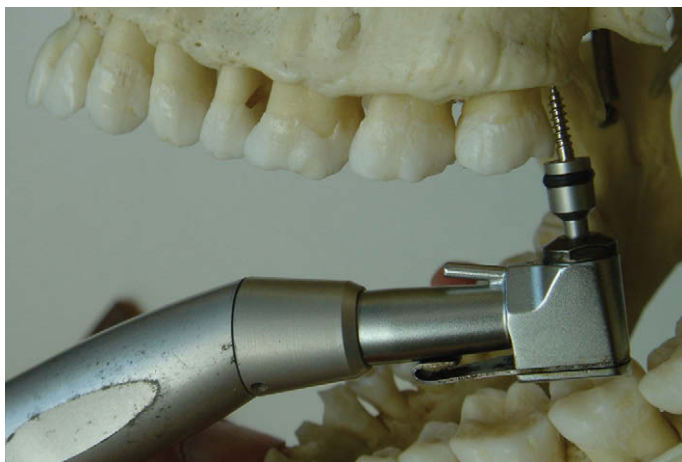


Fig. 5.50 Orientation of the miniscrew is not exactly perpendicular to the bone surface.

The motor-driven handpiece is used as the tuberosity is located at the distal end of the oral cavity. Access is poor here and it is impossible to approach the site with a manual driver. As the region is covered with attached mucosa, an incision is not needed. An effort should be made to place the miniscrew perpendicular to bone (Fig. 5.50). Unless the patient has a lingual orthodontic appliance, the miniscrew should be placed in the buccal surface of the tuberosity, rather than the alveolar crest. A constrictive force vector acts on the dental arch when force is applied from a miniscrew that is placed lingually (Fig. 5.51).

If the maxillary third molars are present the miniscrew cannot be placed on the maxillary tuberosity. After extraction, a waiting period of 3 months is required to allow hard cortical bone to develop to retain a miniscrew.



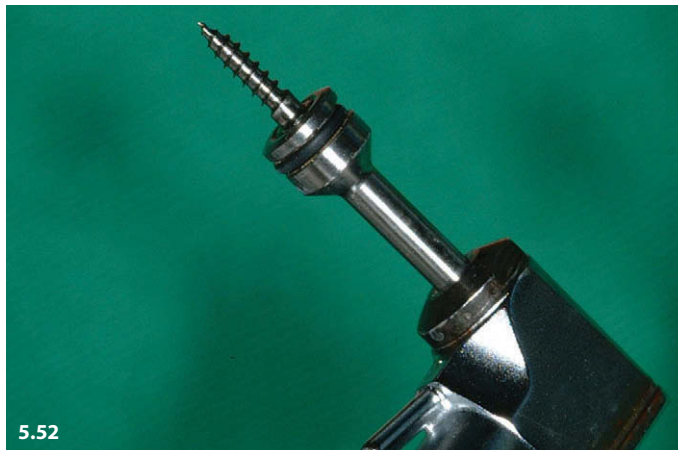
Fig. 5.51 A constrictive force can be introduced when retraction force is applied from a lingually placed miniscrew.

Placement procedure

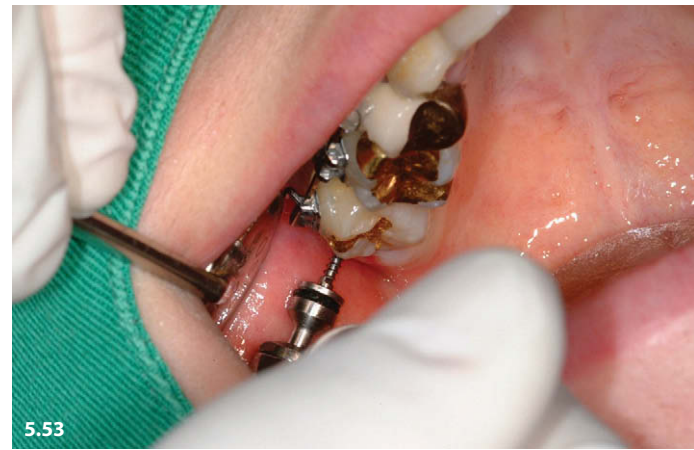
1. Determine the site, mark the soft tissue for placement with a sharp instrument, and check with a mouth mirror.
2. Insert the miniscrew using a contra-angle low-speed handpiece (Fig. 5.52), with light pressure. Make an effort to place the miniscrew perpendicular to the bone. Unless lingual brackets

are used, the miniscrew should be on the buccal side, and almost parallel to the long axis of the upper molars (Fig. 5.53).

3. Detach the handpiece from the miniscrew by pulling the handpiece from the miniscrew head (Figs 5.54, 5.55).



5.52



5.53



5.54



5.55

Figs 5.52–5.55 Placing a miniscrew in the maxillary tuberosity area.

Removing a miniscrew from the maxillary tuberosity

A handpiece is required to remove a miniscrew from the maxillary tuberosity. The connecting bur is used to grab the miniscrew head and rotated **counterclockwise**. No anesthesia is required.

Retromolar pad

Miniscrews are placed in the retromolar pad area when distal retraction of the whole mandibular dentition is planned.¹⁷ There are no critical anatomic structures in this area. Compared with the insertion of miniplates,¹⁸ the surgical procedure for miniscrew insertion is simpler and associated with less morbidity and trauma. As miniscrew placement in the retromolar pad requires more invasive procedure than other regions of the jaws, it is often carried out by an oral surgeon.



Fig. 5.56 A retromolar miniscrew is located slightly buccally in the retromolar triangle.

If the mandibular third molars have been recently extracted, a waiting period of at least 3 months is needed before inserting the miniscrew. The appropriate location of the miniscrew is slightly buccal to the buccolingual center of the retromolar triangle (bull's eye) (Fig. 5.56). The lingual side of internal oblique ridge should be avoided as there is a substantial bony undercut and the lingual nerve and vessels run close by. Palpation of the outer oblique ridge helps to locate the optimal area for miniscrew placement (Fig. 5.57).

The soft tissue in the retromolar pad area is thick and is composed of non-keratinized mucosa. Thus an incision before and suturing after the placement is always required. A long miniscrew (>8 mm) or a miniscrew with a longer neck (Fig. 5.13) is used. The retromolar bone is very dense and pilot drilling may be necessary before miniscrew placement. As in the midpalatal bone area, the initial half of the miniscrew is inserted using a motor-driven handpiece and the second half using a hand driver.



Fig. 5.57 Palpation of the outer oblique ridge helps to locate the optimal placement area.

The high cortical bone density is favorable for miniscrew retention. Even just 3 mm engagement of the miniscrew in the retromolar bone can withstand orthodontic force despite the dislodging moment acting on the miniscrew. There is no advantage of inserting the miniscrew to its full length. It is more convenient and more comfortable for the patient to have the miniscrew inserted partially but enough for firm retention, and to have the head exposed in the oral cavity. In this way the elastomeric ligature can be directly connected to the miniscrew and the **open-pull method** (Figs 5.11, 5.12) can be used. A request should be made to the oral surgeon not to drive in the miniscrew completely into the retromolar bone.

If the soft tissue overlying the retromolar pad is very thick, it may not be possible to have the miniscrew head exposed. The miniscrew is embedded in the mucosa and **closed-pull method** (Figs 5.15, 5.16) is used. A .012 steel ligature wire is tied around the miniscrew and braided. The free ends of the braided wire are exposed in the oral cavity and bent to form a hook. An elastomeric module such as an elastic chain or a nickel-titanium coil spring is connected to the hook for force application. The authors call this arrangement a **retromolar clutch (knob)**. The ligature wire used for the retromolar clutch must not be too thin or too thick. Too thin a wire, such as .010 or .011 wire, may deform or break, whereas too thick a wire will be stiff and cause irritation during function. When referring a patient to an oral surgeon for the placement of the miniscrew, the orthodontist must provide the orthodontic ligature wire.

Removing a retromolar miniscrew

Closed-pull retromolar miniscrews should be removed by an oral surgeon. Open-pull retromolar miniscrew can be removed by an orthodontist. Infection may occur when the soft tissue is thick. Chlorhexidine mouth rinse is prescribed to prevent inflammation.

POST-PLACEMENT INSTRUCTIONS FOR THE PATIENT

After the miniscrew is placed, the precautions are explained to the patient. Written instructions are also given. The patient is informed that they may have pain but it will not last for more than 1–2 days. They can take simple, over-the-counter analgesics if required. Aspirin is not recommended as its anti-inflammatory properties have been reported to inhibit tooth movement. The patient can brush their teeth as usual, but they should be cautious not to tap the screw with the plastic part of the toothbrush. A toothbrush with very soft bristles should be recommended.

Instructions for the patient

- The surgery site can be painful after the anesthesia wears off. Take an over-the-counter pain killer (not aspirin) if needed.
- Avoid eating hard foods.
- Don't touch the miniscrew with the tongue or fingers as it can compromise its union with the bone.
- Gently brush the miniscrew while brushing your teeth with a soft bristle toothbrush.
- Be careful not to tap the miniscrew head with your toothbrush.

TIMING OF INITIAL FORCE APPLICATION

The timing of application of the initial force after implantation, with respect to osseointegration, is controversial. The relative motion between the implant and the healing bone during the early stages of healing interferes with osseointegration.¹⁹ For this reason, some authors suggest delaying force application by a period of at least 4–5 months to attain maximum osseointegration.²⁰ However, whereas there is a need to wait for osseointegration to occur when using conventional implants and onplants for skeletal anchorage, osseointegration is not necessary when using miniscrew implants for orthodontic anchorage. These screws have been shown to remain

immobile in studies in which orthodontic force was applied immediately after screw fixation.⁷ In all the cases illustrated in the subsequent chapters of this book, the force was applied 1 week after insertion of the miniscrew, to allow soft tissue healing to occur. For intermaxillary fixation, the wires were engaged immediately.

Even though osseointegration between the miniscrew and the bone is not required for orthodontic uses, there is some microscopic evidence of osseointegration from an animal study.¹⁴ Since miniscrews have a small diameter, they are relatively easy to remove even in the event of osseointegration as the removal torque is proportional to the square of the screw diameter.

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MINISCREW IMPLANT ANCHORAGE FOR ANTEROPOSTERIOR TOOTH MOVEMENT

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INTRODUCTION

Depending on the location of the miniscrew implant, a tooth or a group of teeth can be moved in the anterior or posterior direction with the miniscrew implant providing anchorage. This chapter describes four applications of miniscrew implant anchorage for anteroposterior movement of teeth:

- Providing absolute anchorage when mesial movement of posterior teeth is not indicated
- For distal movement of the maxillary or mandibular dentition or both
- For molar distalization
- For mesial movement of the posterior teeth

USE OF MINISCREW IMPLANTS FOR ABSOLUTE ANCHORAGE WHEN MESIAL MOVEMENT OF POSTERIOR TEETH IS NOT INDICATED

The term ‘anchorage’ in orthodontics is used to describe the resistance to tooth movement resulting from reciprocal forces.¹ Maximum anchorage refers to the situation where, strictly speaking, no such movement must occur if treatment goals are to be achieved. Anchorage can be quantified according to the amount of movement of the posterior teeth desired to close the residual extraction space.² In that context, these authors defined maximum anchorage as a situation in which not more than 25% of the extraction space must close by mesial movement of posterior teeth.

There are several ways of enhancing anchorage in orthodontics. The simplest way is by including more and larger teeth in the anchorage unit. Other traditional methods of additional anchorage reinforcement include headgear and transpalatal bars. However, these methods have some disadvantages, such as complicated appliance design and the need for substantial patient cooperation. The orthodontic miniscrew implant can replace any auxiliary, compliance-dependent appliance used to reinforce the anchorage value of the posterior teeth and can provide sufficient anchorage to withstand the reciprocal force produced by the retraction force applied to the anterior teeth. When a miniscrew implant is maximally effective, there is no mesial movement of the posterior teeth, and hence the term absolute anchorage can be used in these situations.

CASE 6.1

Maximum anchorage in a patient with bimaxillary protrusion

Presenting complaint and clinical examination

A 22-year-old Korean woman presented with bimaxillary protrusion. She had a convex profile with severe lip protrusion and incompetence, and mentalis strain was noted on closure of the lips. The face was

asymmetric with the left side appearing longer. Her smile line was also asymmetric (Figs 6.1–6.4). She was a mouth breather. There was clicking in both temporomandibular joints, but there was no pain.



Fig. 6.1



Fig. 6.2



Fig. 6.3



Fig. 6.4

Intraoral examination showed good oral hygiene, Class I canine and molar relationships on both sides with an overjet of 3.0 mm, and mild upper and lower anterior crowding. The teeth were generally large in size and the dental and facial midlines were coincident (Figs 6.5–6.10).

Radiographic evaluation

The panoramic radiograph (Fig. 6.11) revealed all the teeth were present except the third molars.



Fig. 6.5



Fig. 6.6



Fig. 6.7



Fig. 6.8



Fig. 6.9



Fig. 6.10



Fig. 6.11

Cephalometric analysis (Figs 6.12, 6.13; Table 6.1) revealed skeletal Class I bimaxillary protrusion. Both the upper and the lower incisors were proclined. The



Fig. 6.12



Fig. 6.13

lower lip was protrusive relative to the E (esthetic) line. The maxillo-mandibular planes angle and GoMn/SN angle were increased.

Table 6.1 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	80.5
SNB (deg)	77.5
ANB (deg)	3.0

Vertical

GoMe/SN (deg)	36.0
FMPA (deg)	28.0
PP/MP (deg)	20.0
Lower gonial (deg)	75.0
ANS–Me (mm)	78.5

DENTAL ANALYSIS

Overjet (mm)	3.0
Overbite (mm)	1.0
UI/SN (deg)	114.0
L1/GoMe (deg)	106.0
SN/OP (deg)	19.0
Is–Is' (mm)	32.0
Mo–Ms (mm)	28.5
li–li' (mm)	54.0
Mo–Mi (mm)	43.0

LIP ANALYSIS

U Lip–E (mm)	0.0
L Lip–E (mm)	8.5
NLA (deg)	80.5

See page ix for Korean norms.
Is–Is': Upper anterior dentoalveolar height (UI–NF)
li–li': Lower anterior dentoalveolar height (LI–GoMe)
Mo–Ms: Upper posterior dentoalveolar height (U6–NF)
Mo–Mi: Lower posterior dentoalveolar height (L6–GoMe)

Treatment objectives and plan

The treatment objective was maximum retraction of the upper and lower anterior teeth and reduction of lip protrusion. The treatment plan was to extract the four first premolars and reduce the dentoalveolar protrusion. Maximum anchorage would be provided with four miniscrew implants placed in the inter-radicular buccal alveolar bone in each quadrant to avoid mesial movement of the posterior teeth. The extraction space would be closed mostly by retraction of the anterior teeth to maximize reduction in lip protrusion.

Treatment

After extraction of the four first premolars, the upper and lower arches were bonded with .022/.028 preadjusted fixed appliances. A transpalatal arch was fitted on the upper first molars. Following leveling and aligning, .019/.025 stainless steel working archwires were inserted in both arches.

Miniscrew implant anchorage and space closure

Six months into treatment, two Martin® miniscrew implants (diameter 1.6 mm, length 6.0 mm) were placed in the upper arch between the second premolar and first molar on the right side and between the first and second molars on the left side. The position of the miniscrew implant was determined by assessing the inter-radicular distances in the panoramic radiograph. These miniscrew implants served as direct anchorage units for retraction of the proclined incisors. A manual screwdriver (hand driver) was used for insertion. The length was selected on the basis of the thickness of the mucosa at the insertion site. An incision was not necessary because the soft tissue was very thin. Periapical radiographs taken after insertion verified the absence of contact between the screw and the neighboring tooth roots (Figs 6.14, 6.15). The patient

was given the usual post-insertion oral hygiene and care instructions (see Chapter 5).

The head of the miniscrew was left exposed in the oral cavity to facilitate force application, which was started 1 week after insertion to allow the soft tissues to heal. Space closure in the upper arch was started with 150–200 g of force delivered by active tiebacks from the presoldered anterior hooks on the archwire to the miniscrew implants (Figs 6.16, 6.17).

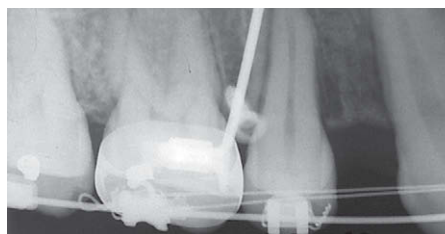


Fig. 6.14



Fig. 6.15



Fig. 6.16

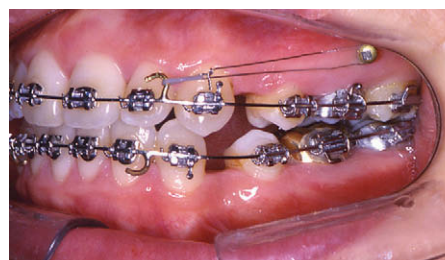


Fig. 6.17

When the treatment plan requires miniscrew placement in the inter-radicular space, it is recommended to place the miniscrews after leveling and aligning of the teeth is complete. This aids in determining the best possible location for the miniscrew and avoids root damage during and after placement. Depending on the initial alignment of the teeth, the timing of miniscrew placement in the upper and lower arches may vary, and some anchorage loss is inevitable during this initial stage of treatment. This patient presented with loose brackets, particularly the mandibular brackets, on several visits during the initial phase, which resulted in a longer time than usual before the stainless steel wires were inserted. As a result, there was more anchorage loss than expected in this phase of treatment.

At 8 months, two Martin® miniscrew implants (diameter 1.6 mm, length 6.0 mm) were placed in the lower arch, in the inter-radicular alveolar bone between the second premolar and first molar on both sides (Figs 6.18, 6.19). On the right side another periapical view was taken with the cone of the x-ray machine placed more distally and directed toward the mesial to verify that the tip of the miniscrew was not in contact with the neighboring root. Again active tiebacks were placed between the hooks on the lower archwire and

the miniscrews on both sides to retract the mandibular anterior teeth.

At the same visit, the upper left miniscrew became loose and was replaced with an OsteoMed® miniscrew (diameter 1.6 mm, length 6.0 mm). As the tieback ligature wire was impinging on the soft tissue it was covered with a plastic sleeve to reduce the gingival irritation (Fig. 6.20). When this patient was being treated, only single head bone screws were available. Soft tissue irritation was commonly seen around the screw when elastics or wires were attached to it. The longer the distance between the screw and point of force application, the more likely it was that the traction devices would impinge on the soft tissues in that area. Currently, orthodontic miniscrews with dual heads (see Chapter 4) are available on the market and their use can minimize this problem.

For bodily retraction of the upper anterior teeth, the hooks on the upper archwire were extended gingivally so that the traction force passed through the center of resistance of the anterior teeth (Figs 6.21, 6.22). The total treatment time was 27 months. After bracket removal, an upper palatal retainer and a lower lingual retainer were bonded and the patient was also given wraparound removable retainers.

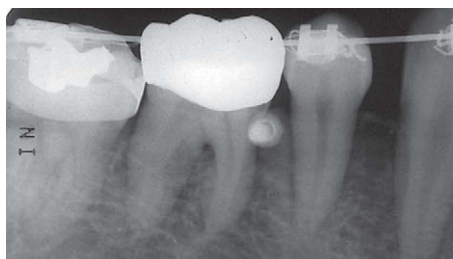


Fig. 6.18

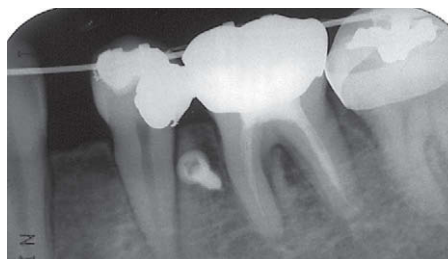


Fig. 6.19



Fig. 6.20



Fig. 6.21



Fig. 6.22

Post-treatment evaluation

The lip protrusion was greatly reduced. Facial esthetics were satisfactory, and good dental occlusion was obtained (Figs 6.23–6.32).

There was minimal root resorption (Fig. 6.33) despite the significant amount of anterior tooth movement.



Fig. 6.23



Fig. 6.24



Fig. 6.25



Fig. 6.26



Fig. 6.27



Fig. 6.28



Fig. 6.29

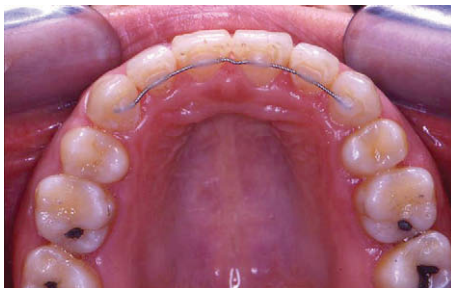


Fig. 6.30



Fig. 6.31



Fig. 6.32



Fig. 6.33

The cephalometric superimpositions show considerable change in the position of the anterior teeth. The upper incisors were retracted by 10.0 mm with a 17.0° reduction in labial inclination. The lower incisors were retracted by 10.0 mm with a 16.0° reduction in labial inclination. The upper and lower molars moved forward

by 1.5 mm and 2.0 mm, respectively. There was little overlap between the pre- and post-treatment incisor position in the superimposition. Considerable amount of alveolar bone remodeling was seen. The mentalis strain on lip closure had disappeared. Vertically, there were minimal changes (Figs 6.34–6.37; Table 6.2).



Fig. 6.34

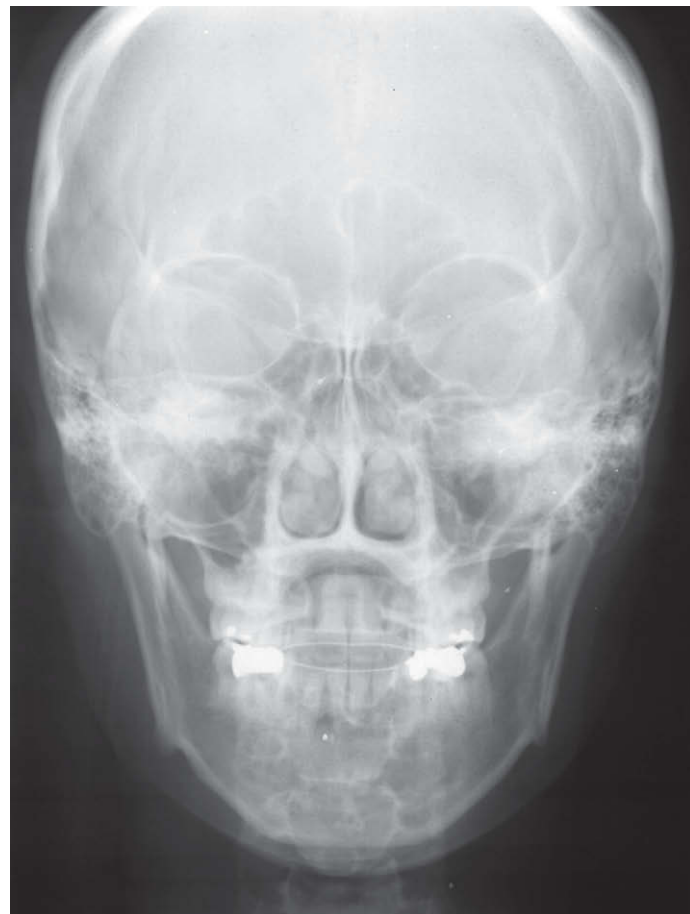


Fig. 6.35



Fig. 6.36

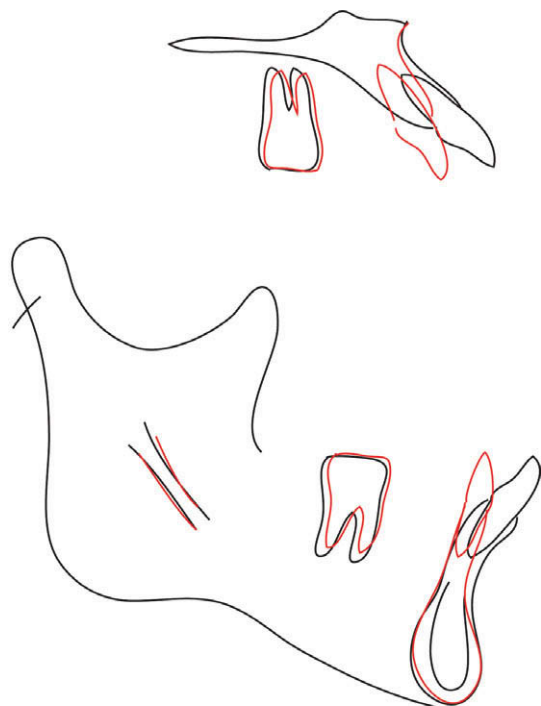


Fig. 6.37

Table 6.2 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	80.5	80.0
SNB (deg)	77.5	75.5
ANB (deg)	3.0	4.5
Vertical		
GoMe/SN (deg)	36.0	37.0
FMPA (deg)	28.0	30.0
PP/MP (deg)	20.0	22.0
Lower gonial (deg)	75.0	77.0
ANS–Me (mm)	78.5	78.0
DENTAL ANALYSIS		
Overjet (mm)	3.0	2.5
Overbite (mm)	1.0	2.0
UI/SN (deg)	114.0	97.0
L1/GoMe (deg)	106.0	90.0
SN/OP (deg)	19.0	22.0
Is–Is' (mm)	32.0	32.0
Mo–Ms (mm)	28.5	28.5
li–li' (mm)	54.0	51.0
Mo–Mi (mm)	43.0	44.5
LIP ANALYSIS		
U Lip–E (mm)	0.0	–4.0
L Lip–E (mm)	8.5	–0.5
NLA (deg)	80.5	82.0

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

At a review visit 2 years 10 months into retention, there were no remarkable changes. The soft tissue of lower face appeared more natural. However, there was

a slight opening of the upper left extraction site because the patient had not been compliant with retainer wear (Figs 6.38–6.48).



Fig. 6.38



Fig. 6.39



Fig. 6.40



Fig. 6.41



Fig. 6.42



Fig. 6.43



Fig. 6.44



Fig. 6.45



Fig. 6.46



Fig. 6.47



Fig. 6.48

Clinical tips

Dual head orthodontic miniscrew implants make application of elastic force easier and cause less soft tissue discomfort to the patient. The chain is stretched between the miniscrew and the archwire hook (Fig. 6.49).

Alternatively, a .012 ligature wire can be tied around the miniscrew head. The wire is braided and the free end bent into a hook (Fig. 6.50). The elastic chain is then stretched between the archwire hook and the braided steel ligature hook. The miniscrew implant does not need to be handled each time chain is replaced.

Placing an active tieback directly on the miniscrew implant is yet another option (Fig 6.51).

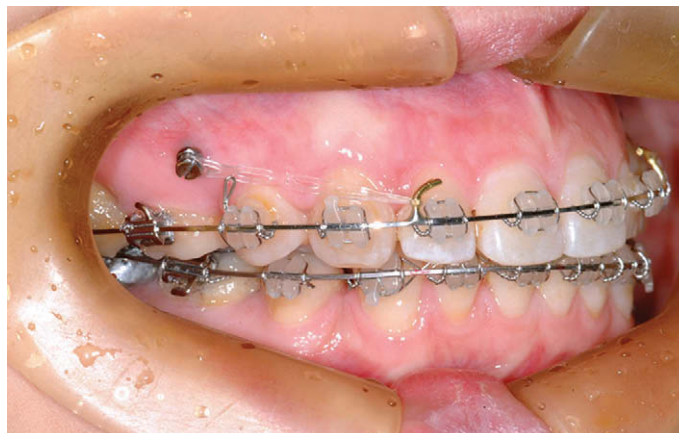


Fig. 6.49

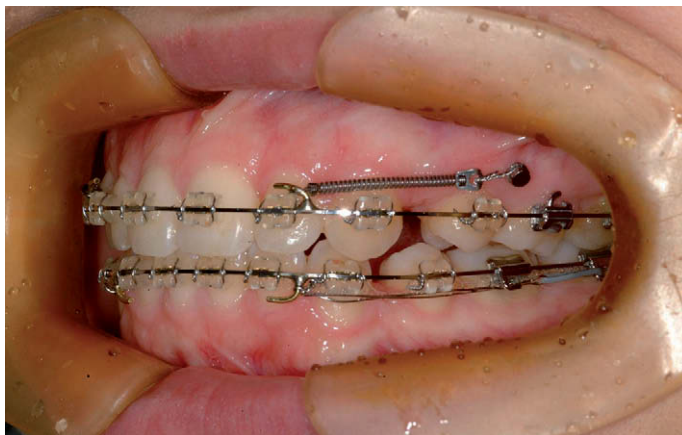


Fig. 6.50

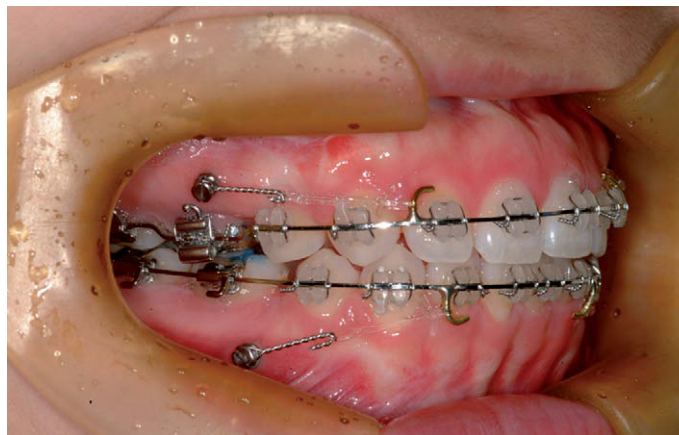


Fig. 6.50b



Fig. 6.51

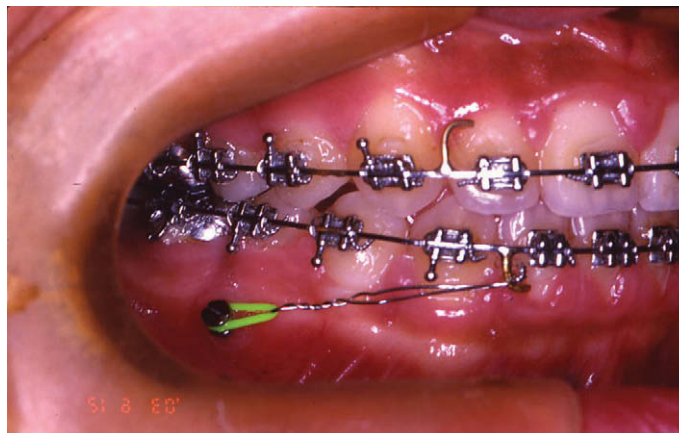


Fig. 6.51b

CASE 6.2

Retraction of anterior teeth in a patient with asymmetric extractions

Presenting complaint and clinical examination

A 21-year-old Korean woman presented with the chief complaint of lip protrusion. She had thick lips and showed mentalis strain on lip closure (Figs 6.52–6.54).



Fig. 6.52



Fig. 6.53



Fig. 6.54

Intraoral examination showed bilateral Class I molar relationships. The upper dental midline was deviated to the left side and the lower dental midline was deviated to the right side. The upper left arch form was distorted because the left second premolar was blocked out palatally (Figs 6.55–6.59).

The panoramic radiograph revealed a full complement of teeth, and all four third molars were impacted. A periapical radiolucency was evident in relation to the lower left second premolar tooth, which had been treated endodontically (Fig. 6.60).



Fig. 6.55



Fig. 6.56



Fig. 6.57



Fig. 6.58



Fig. 6.59



Fig. 6.60

Cephalometric analysis revealed a Class II skeletal relationship with the mandible retrusive in relation to the cranial base. Both the maxillary and the mandibular incisors had normal axial inclinations. The lips were protrusive relative to the E line (Fig. 6.61; Table 6.3).



Fig. 6.61

Table 6.3 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	80.0
SNB (deg)	75.5
ANB (deg)	4.5

Vertical

GoMe/SN (deg)	37.5
FMPA (deg)	30.0
PP/MP (deg)	26.0
Lower gonial (deg)	77.0
ANS–Me (mm)	69.0

DENTAL ANALYSIS

Overjet (mm)	3.0
Overbite (mm)	1.0
UI/SN (deg)	108.0
L1/GoMe (deg)	106.0
SN/OP (deg)	18.0
Is–Is' (mm)	31.5
Mo–Ms (mm)	26.0
li–li' (mm)	44.5
Mo–Mi (mm)	34.8

LIP ANALYSIS

U Lip–E (mm)	1.7
L Lip–E (mm)	3.8
NLA (deg)	96.0

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

Treatment objectives and plan

The treatment objective was to reduce the dentoalveolar protrusion with extraction treatment. As the patient preferred to have the teeth with crowns extracted, it was planned to extract the first premolars on the right side and the second premolars on the left side. Miniscrew implant anchorage was planned to compensate for the asymmetric extraction pattern, with the greater anchorage value on the left side to achieve bilaterally symmetric anterior retraction.

Treatment

After extraction of the four premolars, the upper and lower arches were bonded with .022/.028 preadjusted fixed appliances. A transpalatal arch was fitted on the upper first molars, and leveling and aligning of both arches initiated.

Miniscrew implant anchorage and further treatment

At 3 months, two Jael® miniscrew implants (diameter 1.4 mm, length 8.0 mm) were inserted between the upper right second premolar and first molar and just mesial to the first molar on left side under infiltrative local anesthesia. The archwires were progressively increased up to .019/.025 stainless steel working archwires (Figs 6.62–6.64).

As the upper anterior teeth were retracted, a Class III relationship developed on the left side. An ORLUS® miniscrew implant (diameter 1.6 mm, length 7.0 mm) was placed in the inter-radicular bone between the lower left first and second molars 9 months into treatment. Retraction of anterior teeth was continued with nickel-titanium coil springs (Figs 6.65–6.67). The implants were stable throughout the treatment. The total active treatment time was 30 months.



Fig. 6.62



Fig. 6.63



Fig. 6.64

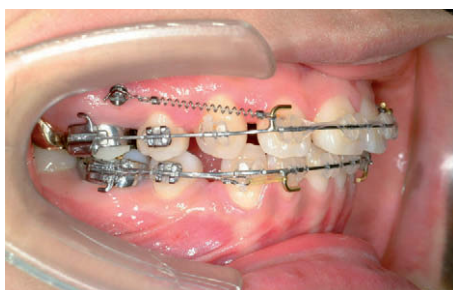


Fig. 6.65



Fig. 6.66

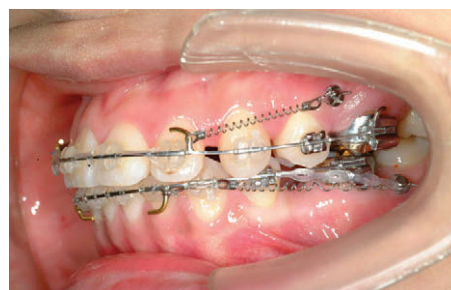


Fig. 6.67

Post-treatment evaluation

The dentoalveolar protrusion was reduced, thus decreasing the lip fullness. Class I canine and molar

relationships with ideal overjet and overbite were established on both sides. The upper and lower dental midlines were aligned with the facial midline (Figs 6.68–6.75).



Fig. 6.68



Fig. 6.69



Fig. 6.70



Fig. 6.71



Fig. 6.72



Fig. 6.73



Fig. 6.74



Fig. 6.75

Superimposition of the pre- and post-treatment cephalometric tracings showed reduction of lip protrusion and elimination of mentalis strain. The upper incisors were retracted by 7.5 mm with a 13.0° reduction in labial inclination. The lower incisors were retracted by 8.5 mm with a 17.0° reduction in labial

inclination. The upper and lower lips were retrusive to the E line. As the anterior teeth were retracted with the help of the miniscrew implants, minimal vertical change was noted in the posterior teeth. The post-treatment panoramic radiograph showed slight amount of root resorption throughout (Figs 6.76–6.79; Table 6.4).

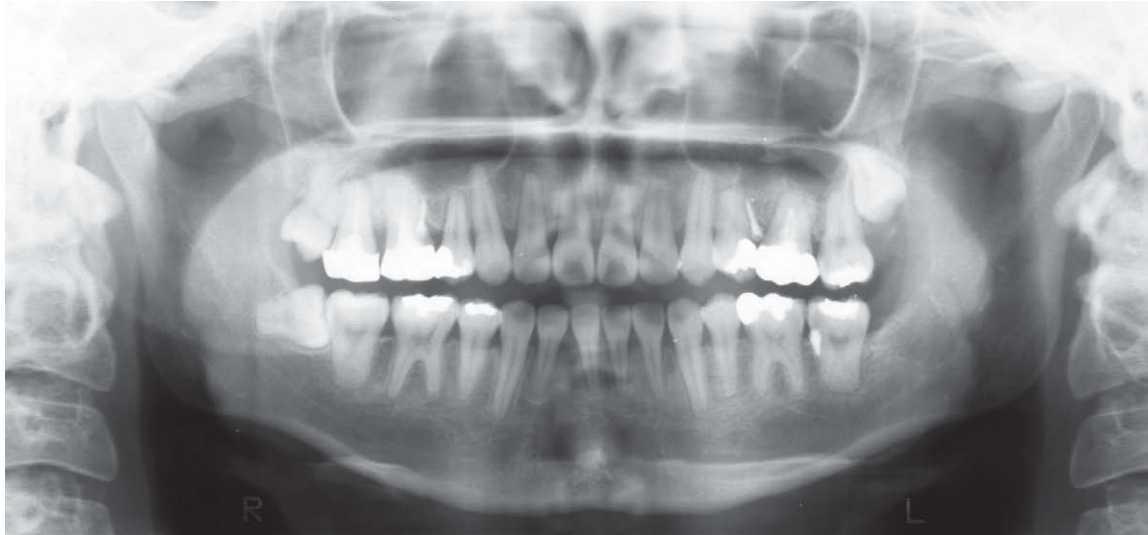


Fig. 6.76



Fig. 6.77

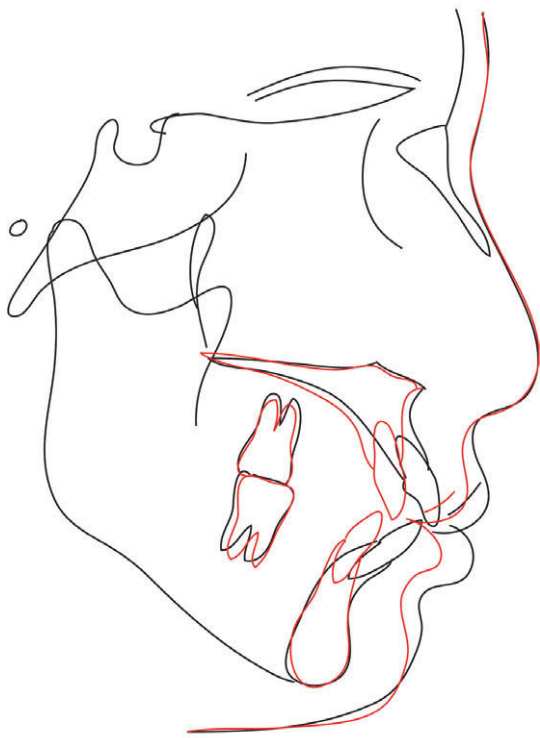


Fig. 6.78

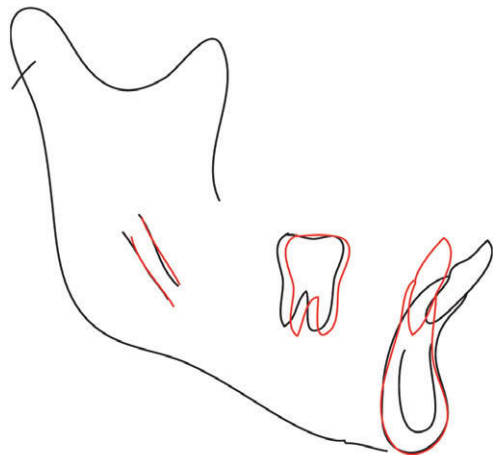
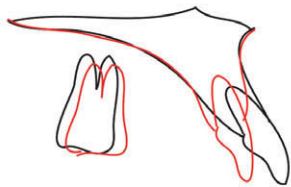


Fig. 6.79

Table 6.4 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	80.0	78.0
SNB (deg)	75.5	74.0
ANB (deg)	4.5	4.0
Vertical		
GoMe/SN (deg)	37.5	38.5
FMPA (deg)	30.0	31.0
PP/MP (deg)	26.0	26.0
Lower gonial (deg)	77.0	77.0
ANS-Me (mm)	69.0	70.0
DENTAL ANALYSIS		
Overjet (mm)	3.0	3.5
Overbite (mm)	1.0	2.0
UI/SN (deg)	108.0	95.0
L1/GoMe (deg)	106.0	89.0
SN/OP (deg)	18.0	20.0
Is-Is' (mm)	31.5	31.0
Mo-Ms (mm)	26.0	27.0
li-li' (mm)	44.5	42.5
Mo-Mi (mm)	34.8	35.5
LIP ANALYSIS		
U Lip-E (mm)	1.7	-2.8
L Lip-E (mm)	3.8	-2.6
NLA (deg)	96.0	106.0

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

MINISCREW IMPLANT ANCHORAGE FOR RETRACTION OF THE ENTIRE DENTITION

En masse movement of the entire dentition is not practically feasible with conventional orthodontic treatment. However, the miniscrew implant serves as a source of stationary anchorage, and a group of teeth can be moved without reciprocal movement of another group of teeth. Therefore en masse movement of the maxillary dentition, mandibular dentition or both dentitions is possible with this type of anchorage system. Borderline cases with mild protrusion or anterior crowding and mild anteroposterior or midline discrepancy can be successfully treated with non-extraction orthodontic treatment and no anterior movement of the teeth.

Common locations of miniscrew implants for this en masse tooth movement are:

- For distal movement of the entire maxillary dentition: posterior midpalatal area, palatal alveolar bone and the maxillary tuberosity area
- For distal movement of the entire mandibular dentition: buccal alveolar bone and the retromolar pad

In terms of bone quality and implant stability, the midpalatal region and the retromolar pad are the best

intraoral sites for miniscrew placement. The midpalatal region consists of dense cortical bone in adults and provides sufficient retention for the implants.^{3–6} However, due to the limited bone height in this area, bone thickness should be measured on the lateral cephalogram prior to implant insertion. The actual vertical bone thickness of the palate is at least 2 mm greater than is apparent on the cephalogram.⁴ The midpalatal bone can retain a 6.0 mm length miniscrew implant – if the incisive canal area is avoided – in patients in whom the midpalatal suture has closed.^{4,7,8} Although there are few critical anatomic structures in these areas except for the incisive canal,⁹ the miniscrew may perforate the nasal floor due to the large individual variation in the bone thickness in the midpalatal region.^{7,8} However, the hard and soft tissues around the penetrating implants are covered with connective tissue and lined with respiratory mucosa,¹⁰ and no adverse tissue reactions have been noted.¹¹

The mandibular molars can be distalized using a skeletal anchorage system consisting of titanium anchor plates and monocortical screws in the retromolar area.¹² Use of miniscrew implant anchorage in the retromolar region can also result in similar amount of distal movement.¹³ The implants are strong enough to resist the retraction force of 200–300 g. Moreover, miniscrew placement requires less extensive surgery than miniplate insertion.

CASE 6.3

Retraction of the upper and lower dentitions in a patient undergoing non-extraction treatment

Presenting complaint and clinical examination

An 18-year-old Korean woman presented with chief complaint of protruded and prominent upper incisors. Her face was symmetric with a convex profile and relatively thick lips. There was a moderate amount of

lip protrusion and mild mentalis strain on lip closure (Figs 6.80–6.83). Upper incisor display at lip repose was 5.0 mm.



Fig. 6.80



Fig. 6.81



Fig. 6.82



Fig. 6.83

Intraoral examination showed a Class II canine relationship on right side with 3.0 mm overjet. There was mild upper anterior crowding. The upper dental midline was coincident with the facial midline but the lower dental midline was 1.3 mm to the right. Tooth size was generally large (Figs 6.84–6.89). The oral hygiene was excellent.

Radiographic evaluation

The panoramic radiograph revealed a full complement of teeth including the four third molars (Fig. 6.90).



Fig. 6.84



Fig. 6.85



Fig. 6.86



Fig. 6.87



Fig. 6.88



Fig. 6.89



Fig. 6.90

Cephalometric analysis revealed a mild skeletal Class II relationship with proclination of the upper and the lower incisors. The lips were protrusive relative to the E line. The maxillo-mandibular planes, lower gonial and GoMe/SN angles were increased (Fig. 6.91; Table 6.5).



Fig. 6.91

Treatment objectives and plan

The patient desired non-extraction treatment. The initial treatment plan was to provide space by interproximal stripping of the upper and lower anterior teeth followed by retraction of the anterior teeth. During space closure a high-pull headgear would be used to minimize forward and downward movement of the upper molars.

Table 6.5 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	82.0
SNB (deg)	76.0
ANB (deg)	6.0

Vertical

GoMe/SN (deg)	41.0
FMPA (deg)	32.0
PP/MP (deg)	27.0
Lower gonial (deg)	79.0
ANS–Me (mm)	69.0

DENTAL ANALYSIS

Overjet (mm)	3.0
Overbite (mm)	1.5
UI/SN (deg)	113.0
L1/GoMe (deg)	101.0
SN/OP (deg)	20.5
Is–Is' (mm)	31.0
Mo–Ms (mm)	24.0
li–li' (mm)	45.5
Mo–Mi (mm)	35.0

LIP ANALYSIS

U Lip–E (mm)	1.0
L Lip–E (mm)	6.5
NLA (deg)	91.0

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

Treatment

A transpalatal arch was fitted on the upper molars and interproximal stripping of the upper and lower six anterior teeth was done. The upper central incisors and lower arch were bonded with .022/.028 preadjusted fixed appliances. The upper central incisors were intruded using a utility archwire during leveling and aligning of the lower arch (Figs 6.92–6.94). A high-pull headgear was also worn.

Two months later, the rest of the upper teeth were bonded and the archwire size progressively increased up to .019/.025 stainless steel (Fig. 6.95).

After a year of treatment, the patient complained that her lips were still protrusive. Her smile was slightly gummy and showed too much teeth, with no buccal corridors (Figs 6.96–6.98).



Fig. 6.92

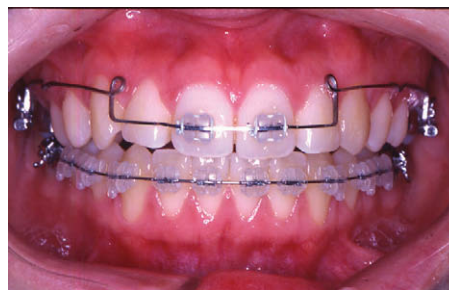


Fig. 6.93



Fig. 6.94



Fig. 6.95



Fig. 6.96



Fig. 6.97



Fig. 6.98

Miniscrew implant anchorage and further treatment

Further treatment was planned with extraction of all four third molars to facilitate distalization of the entire maxillary and mandibular dentitions using miniscrew implants as skeletal anchorage. Three miniscrews (OsteoMed®; diameter 1.6 mm, length 6.0 mm) were inserted under infiltrative anesthesia: one in the midpalatal region, between the first and second molars in the sagittal plane and the remaining two miniscrews between the right and left mandibular second premolars and first molars. A lateral cephalogram and periapical radiographs were taken after placement of the screws to verify their positions (Figs 6.99–6.101).

The maxillary dentition was treated as one unit by placing active tiebacks between the molar hooks and presoldered hooks on the main archwire. Then posterior movement of the entire maxillary dentition was started by applying traction between the midpalatal miniscrew implant to the transpalatal arch (Fig. 6.102).

In the mandibular arch, a retractive force was applied from the miniscrews to the anterior hooks on the main archwire. The ligature wire was covered with a plastic sleeve to reduce soft tissue impingement (Fig. 6.103). As the dentition moved posteriorly, the distance between the transpalatal arch and the midpalatal miniscrew decreased. The design of the transpalatal arch was modified to facilitate further force application (Fig. 6.104).

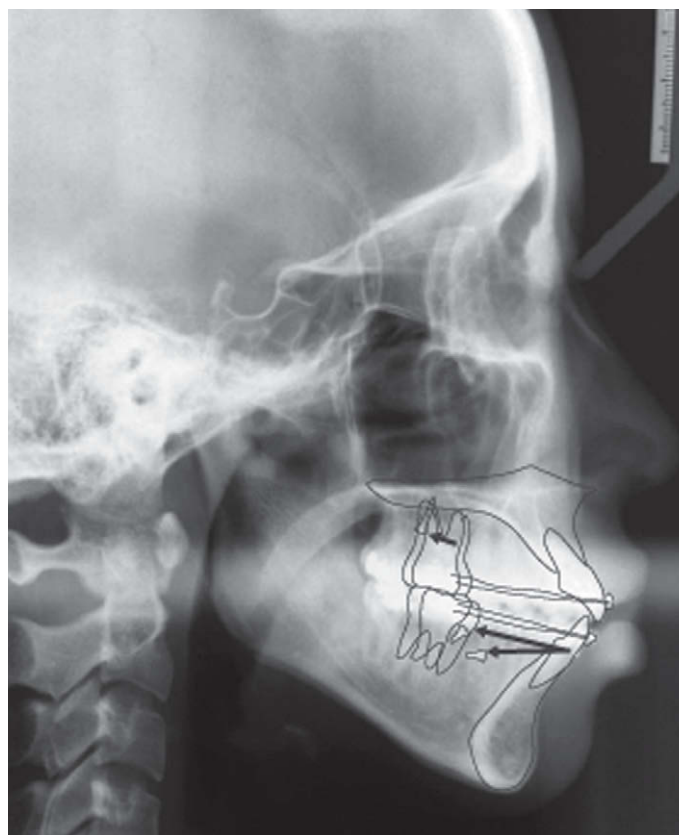


Fig. 6.99



Fig. 6.100



Fig. 6.101



Fig. 6.102

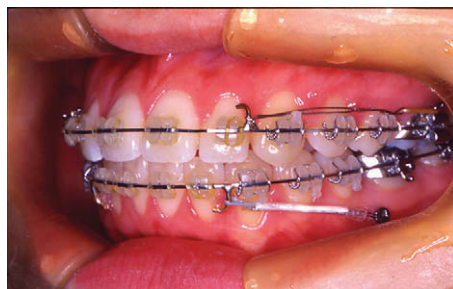


Fig. 6.103



Fig. 6.104

Post-treatment evaluation

There was an improvement in the patient's profile. Lip protrusion was reduced, and although they were still mildly protrusive, the mentalis strain had disappeared. The buccal corridors were visible during smiling. The axial inclination of the upper and lower incisors was improved, with bilateral Class I canine and molar

relationships. Ideal overjet and overbite had been established, with alignment of the upper and lower midlines (Figs 6.105–6.114).

The post-treatment panoramic radiograph showed uprighting of the posterior teeth as the teeth had moved distally (Fig. 6.115).



Fig. 6.105



Fig. 6.106



Fig. 6.107



Fig. 6.108



Fig. 6.109



Fig. 6.110



Fig. 6.111



Fig. 6.112

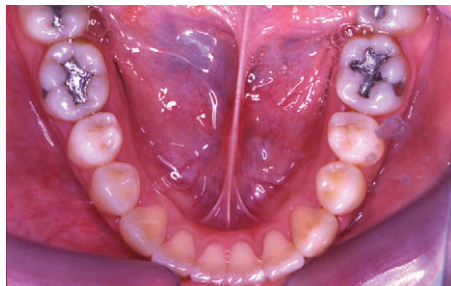


Fig. 6.113



Fig. 6.114



Fig. 6.115

Superimposition of the pre- and post-treatment cephalometric tracings showed distal movement of the entire upper and lower dentitions. The upper incisors were retracted by 5.0 mm with 5.5° reduction in labial inclination. The lower incisors were retracted by 3.0 mm and tipped lingually by 9.0°. The upper and

lower molars moved distally by 1.8 mm and 0.8 mm, respectively. The upper molars were intruded by 0.8 mm as intrusive force had been applied in the upper arch. In contrast, the lower molars were extruded by 0.8 mm and minimal change was noted in the lower anterior facial height (Figs 6.116–6.118; Table 6.6).



Fig. 6.116

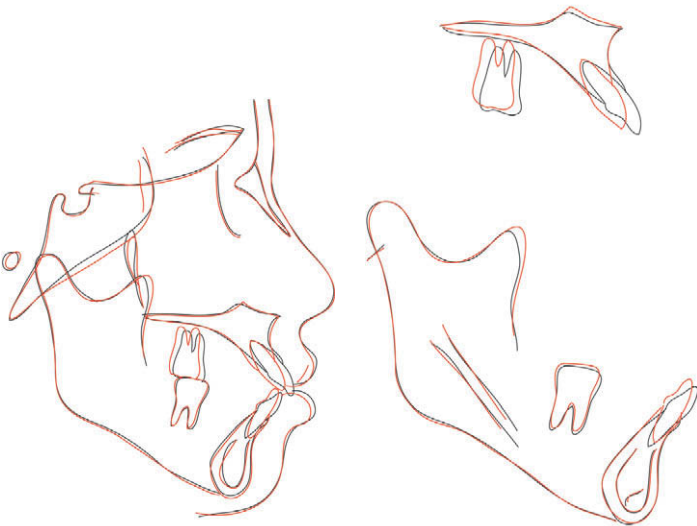


Fig. 6.117

Fig. 6.118

Table 6.6 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	82.0	81.0
SNB (deg)	76.0	76.0
ANB (deg)	6.0	5.0
Vertical		
GoMe/SN (deg)	41.0	41.5
FMPA (deg)	32.0	31.5
PP/MP (deg)	27.0	27.0
Lower gonial (deg)	79.0	79.0
ANS–Me (mm)	69.0	68.5
DENTAL ANALYSIS		
Overjet (mm)	3.0	2.0
Overbite (mm)	1.5	1.0
UI/SN (deg)	113.0	107.5
L1/GoMe (deg)	101.0	92.0
SN/OP (deg)	20.5	21.5
Is–Is' (mm)	31.0	29.0
Mo–Ms (mm)	24.0	24.0
li–li' (mm)	45.5	46.0
Mo–Mi (mm)	35.0	35.5
LIP ANALYSIS		
U Lip–E (mm)	1.0	0.0
L Lip–E (mm)	6.5	4.5
NLA (deg)	91.0	96.0

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

At follow-up after 3 years and 5 months there were no significant changes in the facial esthetics, although the dental midline discrepancy had recurred (Figs 6.119–6.128).



Fig. 6.119



Fig. 6.120



Fig. 6.121



Fig. 6.122



Fig. 6.123



Fig. 6.124



Fig. 6.125



Fig. 6.126

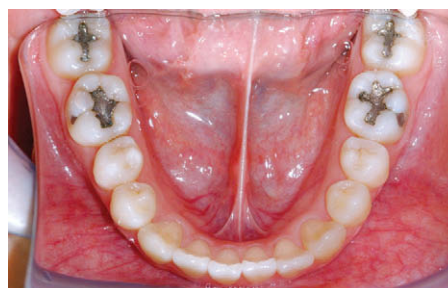


Fig. 6.127



Fig. 6.128

Clinical tip

The depth of the palatal vault should be taken into consideration when determining the location for the midpalatal miniscrew implant. In patients with a deep palatal vault, the line of the retraction force passes further apical to the center of resistance which results in more distal movement of the roots than the crowns of the molars (Figs 6.129, 6.130). In such a situation, the miniscrew implant should be inserted in the buccal or palatal alveolar bone. The line of force then passes near the center of resistance of the teeth and allows more bodily tooth movement. The patient in Case 6.3 had a relatively shallow palate and the upper dentition was retracted using midpalatal miniscrew anchorage.

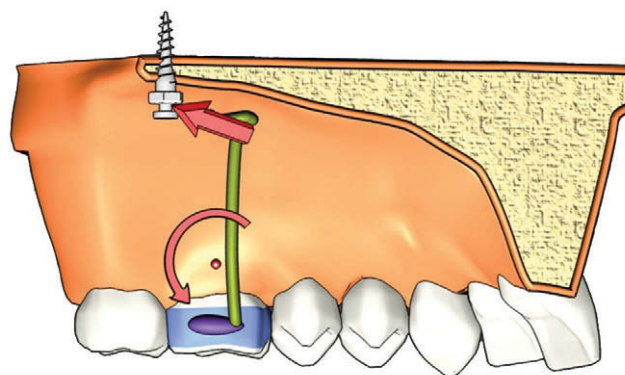


Fig. 6.129

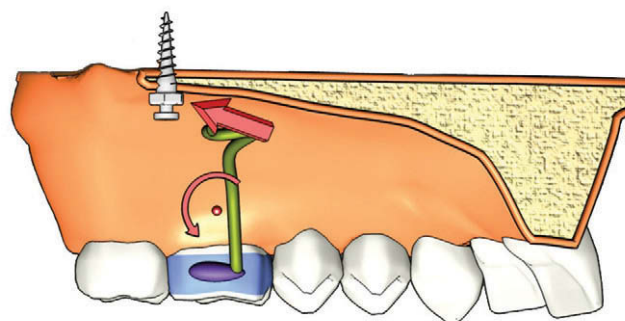


Fig. 6.130

CASE 6.4

Retraction of the upper and lower dentition in a patient with skeletal Class III bimaxillary protrusion

Presenting complaint and clinical examination

A 22-year-old Korean man presented with the chief complaint of lip protrusion. He had thick lips, and lip and mentalis strain was noted on lip closure. The frontal view showed the face was asymmetric with

mandibular deviation to right side. Occlusal canting was seen on smiling, and he had a lip biting habit (Figs 6.131–6.134).



Fig. 6.131

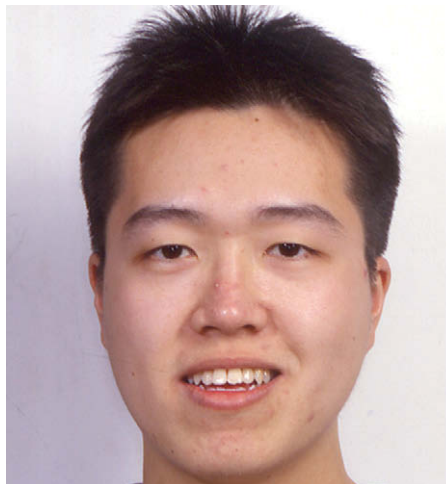


Fig. 6.132



Fig. 6.133



Fig. 6.134

Intraoral examination showed Class III canine and molar relationships on both sides, with the upper and lower lateral incisors in an edge to edge bite. The upper dental midline was centered but the lower dental midline was deviated 1.0 mm toward the right side. Alignment of the teeth was fair, with a broad U-shaped upper arch form and a square-shaped lower arch. Gingival recession was seen on upper right first premolar. The oral hygiene was fair (Figs 6.135–6.140).

Radiographic evaluation

The panoramic radiograph revealed a full complement of teeth with impaction of all four third molars. Slight horizontal alveolar bone loss was evident. The left condyle was slender in shape and the distance between condyle head and the antegonial notch on left side was greater than on the right side (Fig. 6.141).



Fig. 6.135



Fig. 6.136



Fig. 6.137



Fig. 6.138

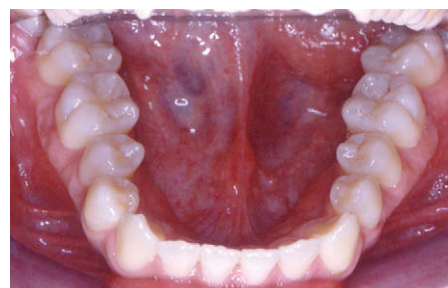


Fig. 6.139



Fig. 6.140



Fig. 6.141

Cephalometric analysis revealed a skeletal Class III relationship with a prognathic mandible. The upper incisors were proclined and lower incisors were well positioned relative to the apical base. The

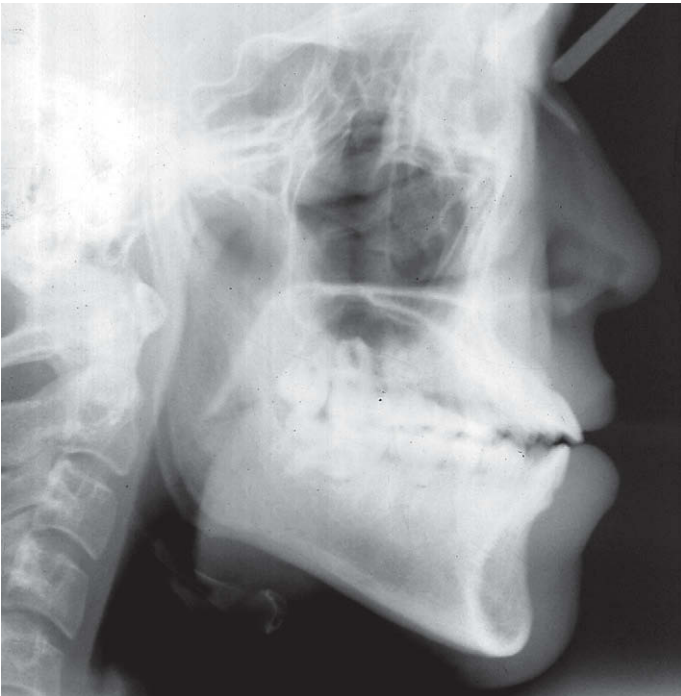


Fig. 6.142



Fig. 6.143

posteroanterior (PA) cephalogram revealed mandibular deviation to the right side, with asymmetry of the mandibular contour (Figs 6.142, 6.143; Table 6.7).

Table 6.7 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS	
Anteroposterior	
SNA (deg)	83.5
SNB (deg)	83.5
ANB (deg)	0.0
Vertical	
GoMe/SN (deg)	32.0
FMPA (deg)	23.0
PP/MP (deg)	22.0
Lower gonial (deg)	78.0
ANS–Me (mm)	85.5
DENTAL ANALYSIS	
Overjet (mm)	3.0
Overbite (mm)	0.0
UI/SN (deg)	121.5
L1/GoMe (deg)	97.0
SN/OP (deg)	12.5
Is–Is' (mm)	35.0
Mo–Ms (mm)	33.0
li–li' (mm)	52.0
Mo–Mi (mm)	43.0
LIP ANALYSIS	
U Lip–E (mm)	–2.0
L Lip–E (mm)	2.5
NLA (deg)	94.0

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

Treatment objectives and plan

The treatment objectives were to reduce the lip protrusion, and establish optimal overbite and Class I canine and molar relationships, with alignment of the dental midlines.

Two treatment plans were discussed with the patient. The first plan involved combined orthodontic treatment and bimaxillary orthognathic surgery. The surgical procedures would be a LeFort I osteotomy of the maxilla to intrude the posterior teeth and a bilateral sagittal split osteotomy for mandibular setback with advancement genioplasty. The second plan involved extraction of all four first premolars, followed by retraction of anterior teeth with moderate anchorage to reduce dentoalveolar and lip protrusion. However, the patient declined both treatment plans.

A third plan was devised, involving extraction of all four third molars with retraction of the upper and lower dentitions with the help of miniscrew implant anchorage. A total of four miniscrews would be required, two in the palatal alveolar bone between the upper first and second molars on both sides and the other two in the buccal alveolar bone between the lower first and second molars on both sides. A transpalatal arch and a lower lingual arch would be fitted to stabilize the dentitions during the distal movement. The patient consented to undergo this treatment.

Treatment

After a transpalatal arch and a lower lingual arch were fitted, the patient was referred to an oral surgeon for extraction of all four third molars. At the following visit, four miniscrews were placed. In the maxillary arch two OSAS® miniscrews (diameter 1.6 mm, length 8.0 mm) were placed in the alveolar bone between the first and second molar palatal roots. The soft tissue thickness was checked before selection of the miniscrew length because the soft tissue in this area is quite thick. After giving infiltrative anesthesia, the depth of the overlying mucosa was assessed with the tip of an explorer. A stab incision to the bone surface was made to prevent the thick soft tissue from extending into the bone, which can compromise miniscrew retention. A low-speed 256:1 contra-angle handpiece was used to place the miniscrew. As the posterior teeth have only one palatal root, the inter-radicular distance between the roots is sufficient and palatal root contact is not a major concern during implant placement. However, care should be taken not to perforate the greater palatine vessels.

In the mandibular arch, two OSAS® miniscrews (diameter 1.6 mm, length 8.0 mm) were placed in the buccal alveolar bone between the first and second molars. The alveolar bone in this area was bulbous in this patient and the miniscrews were placed with more vertical orientation, at an angulation of approximately 45° to the bone surface, thus reducing the possibility of root contact. Nevertheless, root proximity was checked on a panoramic radiograph prior to placement, and periapical radiographs were taken after placement to verify the absence of miniscrew–root contact.

In the following week, both arches were bonded with .022/.028 preadjusted fixed appliances and leveling and aligning started. As a transpalatal arch and a lingual arch had already been placed to stabilize the dentitions, an elastic force of 150–200 g per side from each implant was applied right away (Figs 6.144–6.148).

The archwires were progressively increased up to .019/.025 stainless steel working archwires. A retraction force was applied in the maxillary arch with

elastic chains between the hooks on the transpalatal arch and the miniscrews. In the mandible, active tiebacks were used between the archwire hooks and the miniscrews (Figs 6.149–6.153).

After 7 months of retraction, a cephalogram was taken to assess the amount of lingual alveolar bone available for further incisor retraction (Fig. 6.154).

The total treatment time was 14 months.

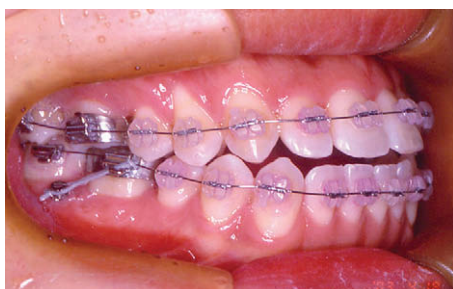


Fig. 6.144



Fig. 6.145

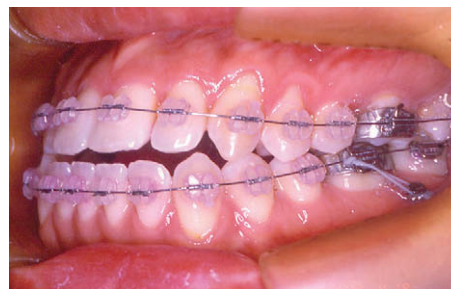


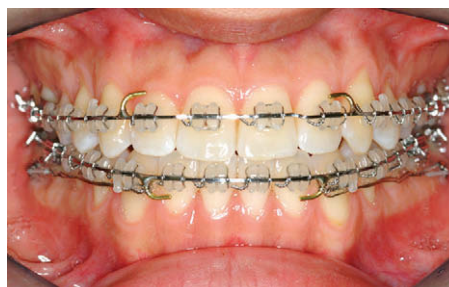
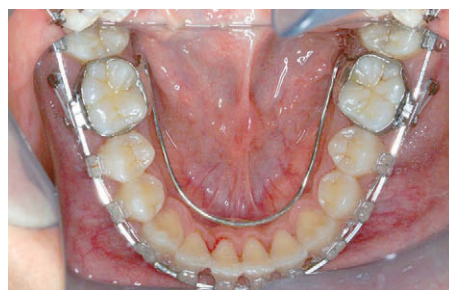
Fig. 6.146



Fig. 6.147



Fig. 6.148

**Fig. 6.149****Fig. 6.150****Fig. 6.151****Fig. 6.152****Fig. 6.153****Fig. 6.154**

Post-treatment evaluation

Dentoalveolar protrusion was reduced, thus decreasing the lip fullness. Mild lip protrusion and lip strain

remained and the labiomental sulcus was still shallow (Figs 6.155–6.158).



Fig. 6.155



Fig. 6.156



Fig. 6.157



Fig. 6.158

Super Class I canine and molar relationships were established on the right side. On the left side, a 1.0 mm Class III relationship was seen. Ideal overjet and overbite were established with alignment of the upper and lower dental midlines (Figs 6.159–6.164).

A panoramic radiograph taken after appliance removal shows the palatal miniscrews (Fig. 6.165). The screws

were removed on the following visit. Uprighting of upper and lower molars was evident due to the distal movement of the upper and lower dentitions against the miniscrew implant anchorage. Bone levels were maintained and minimal apical root resorption was seen in the upper and lower incisors and molars.



Fig. 6.159



Fig. 6.160



Fig. 6.161



Fig. 6.162



Fig. 6.163



Fig. 6.164

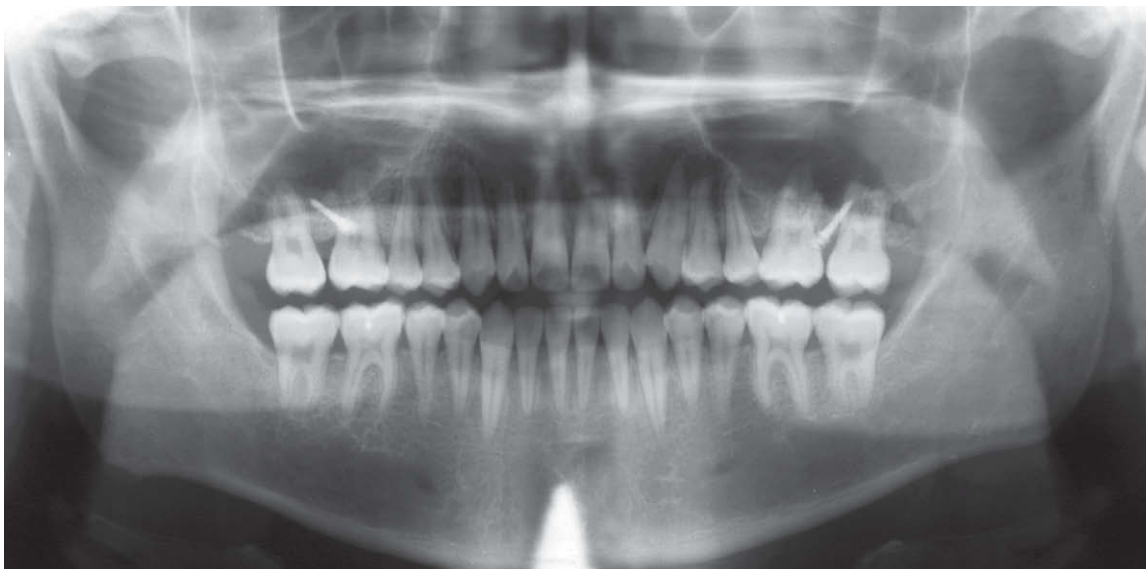


Fig. 6.165

Superimposition of the pre- and post-treatment cephalometric tracings showed lower lip retraction with no change in the vertical dimension. The upper incisors were retracted by 3.0 mm. The lower incisors

were retracted by 3.5 mm with 8.5° reduction in labial inclination. The lower teeth were slightly extruded (Figs 6.166–6.169; Table 6.8).

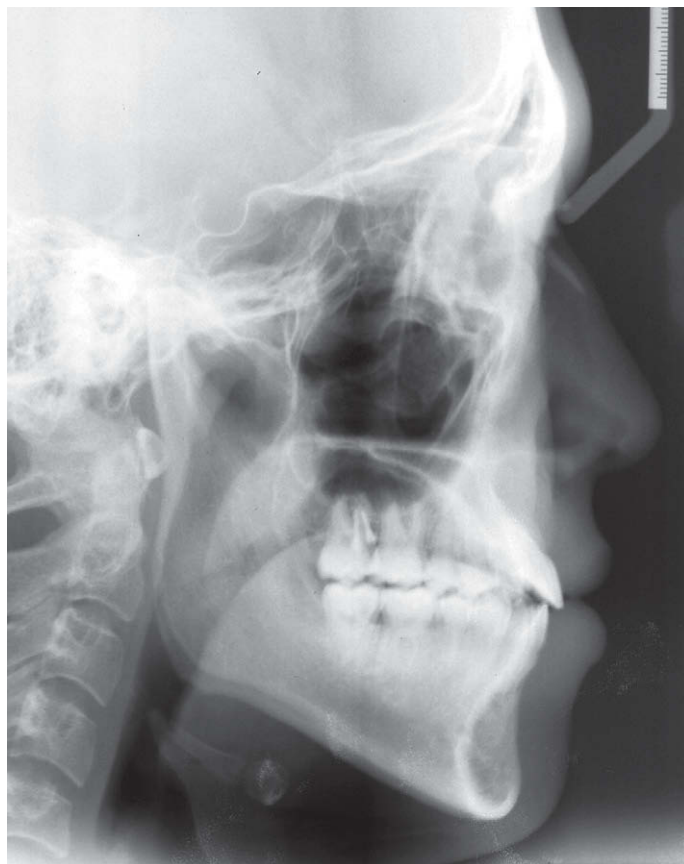


Fig. 6.166

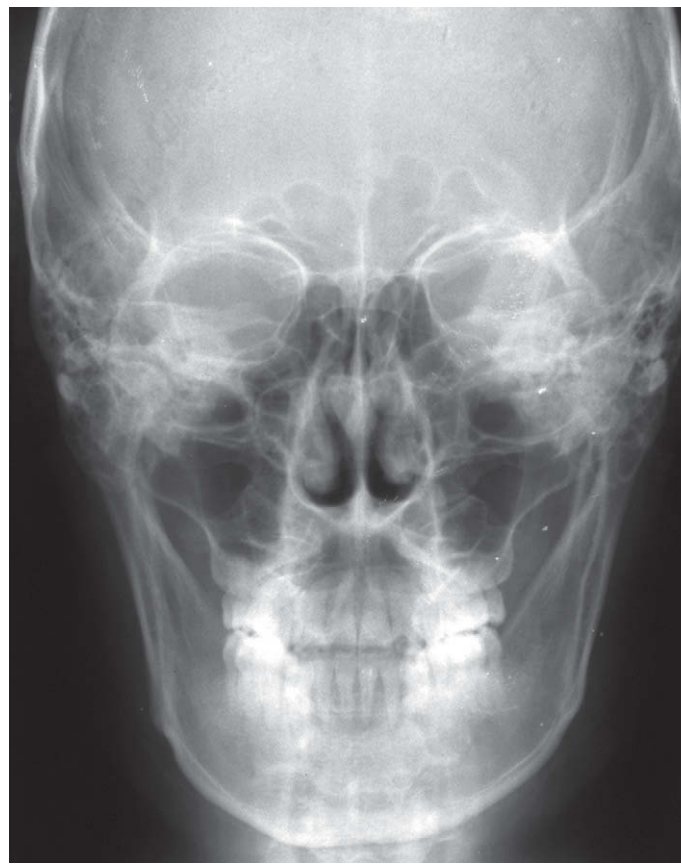


Fig. 6.167

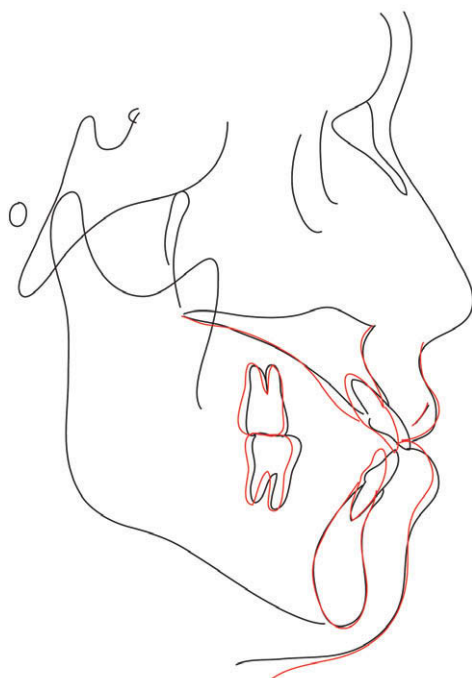


Fig. 6.168

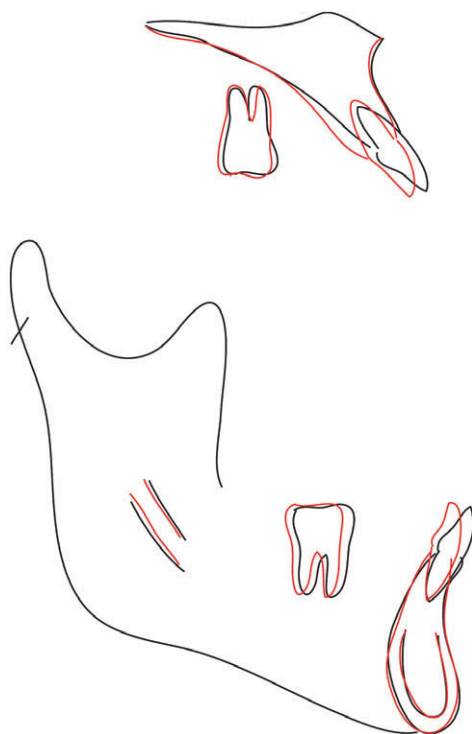


Fig. 6.169

Table 6.8 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	83.5	82.0
SNB (deg)	83.5	83.0
ANB (deg)	0.0	-1.0
Vertical		
GoMe/SN (deg)	32.0	30.5
FMPA (deg)	23.0	24.0
PP/MP (deg)	22.0	21.0
Lower gonial (deg)	78.0	77.5
ANS-Me (mm)	85.5	85.5
DENTAL ANALYSIS		
Overjet (mm)	3.0	3.5
Overbite (mm)	0.0	1.0
UI/SN (deg)	121.5	118.0
L1/GoMe (deg)	97.0	88.5
SN/OP (deg)	12.5	12.5
Is-Is' (mm)	35.0	35.0
Mo-Ms (mm)	33.0	33.0
li-li' (mm)	52.0	51.5
Mo-Mi (mm)	43.0	42.5
LIP ANALYSIS		
U Lip-E (mm)	-2.0	-2.5
L Lip-E (mm)	2.5	0.5
NLA (deg)	94.0	93.5

See page ix for Korean norms.

See Table 6.1 and page x for abbreviations.

Clinical tips

To avoid miniscrew–root contact during en-masse retraction, a vertical orientation of a buccal screw is preferable. This is not always possible, especially when the buccal bone is thin (Figs 6.170, 6.171) and in such patients a mid-palatal screw may be more suitable as in Case 6.3. However, if the shape of the buccal bone permits, miniscrew implants are placed at a vertical angulation on the buccal aspect. In a patient with bulbous buccal alveolar bone, the miniscrew can be placed vertically and the possibility of root contact is significantly reduced (Figs 6.172, 6.173).

Positioning the miniscrew implant further apically is another means of avoiding screw–root contact as the teeth are moved distally past the screw. However, in such situations, the miniscrew head is embedded in the soft tissue and the closed-pull method (see Chapter 5) is used to apply force (Fig. 6.174). Keep in mind, however, that an intrusive force is generated because the line of force has a substantial vertical component. Figure 6.175 shows the open-pull method for comparison.

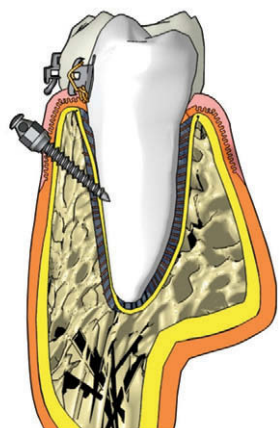


Fig. 6.170

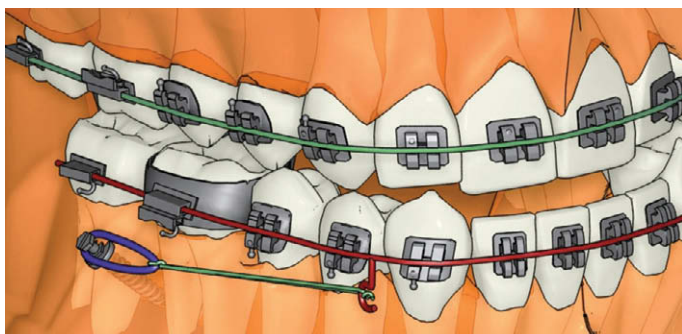


Fig. 6.171

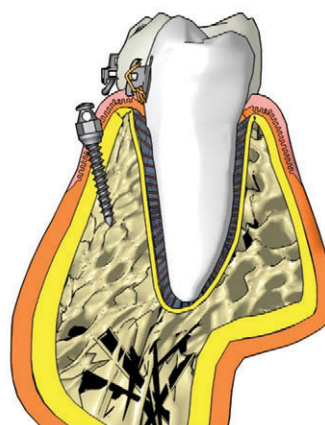


Fig. 6.172



Fig. 6.173

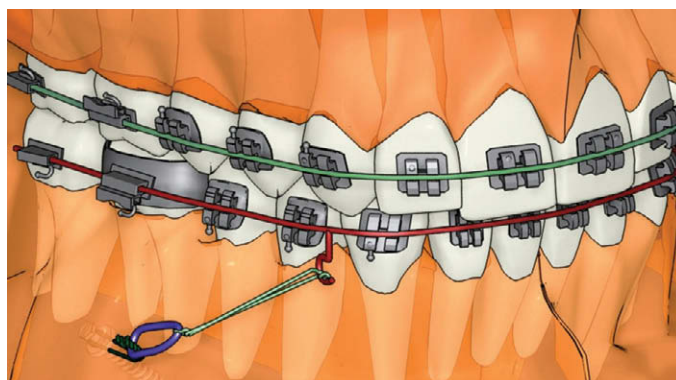


Fig. 6.174

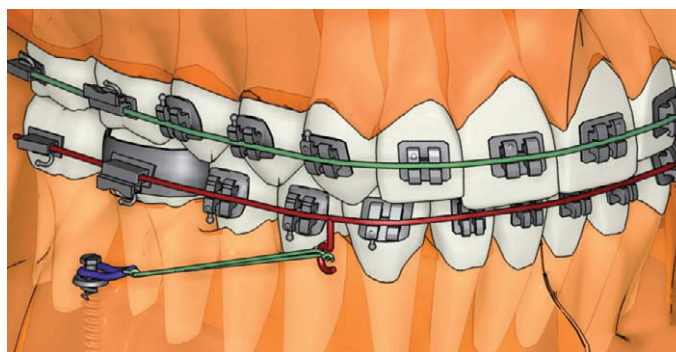


Fig. 6.175

CASE 6.5

Retraction of lower teeth in a patient with skeletal Class III malocclusion with facial asymmetry

Presenting complaint and clinical examination

A 30-year-old Korean man presented with an edge-to-edge bite. He had a concave profile with upper lip

retrusion. His upper incisors were not visible in lip repose (Figs 6.176–6.178).



Fig. 6.176



Fig. 6.177



Fig. 6.178

Intraoral examination showed a midline discrepancy. The upper dental midline was aligned with the facial midline but the lower dental midline was deviated to the left. The canine and molar relationships were Class III on right side, but the canines were in Class II and the molars in Class I relationship on the left side. The maxillary lateral incisors were peg shaped and a crossbite was noted on the left from the incisors through to the premolars. Both arch forms were broad and teeth were well aligned (Figs 6.179–6.183).

Radiographic evaluation

The panoramic radiograph revealed a full complement of teeth except the maxillary left third molar, which was missing. Slight generalized horizontal alveolar bone loss was evident (Fig. 6.184).

Cephalometric analysis revealed a skeletal Class III relationship with the maxilla retrusive relative to the



Fig. 6.179



Fig. 6.180



Fig. 6.181



Fig. 6.182



Fig. 6.183



Fig. 6.184

cranial base. The upper and lower incisors were well positioned over the basal bone. The upper lip was retrusive relative to the E line (Fig. 6.185; Table 6.9).



Fig. 6.185

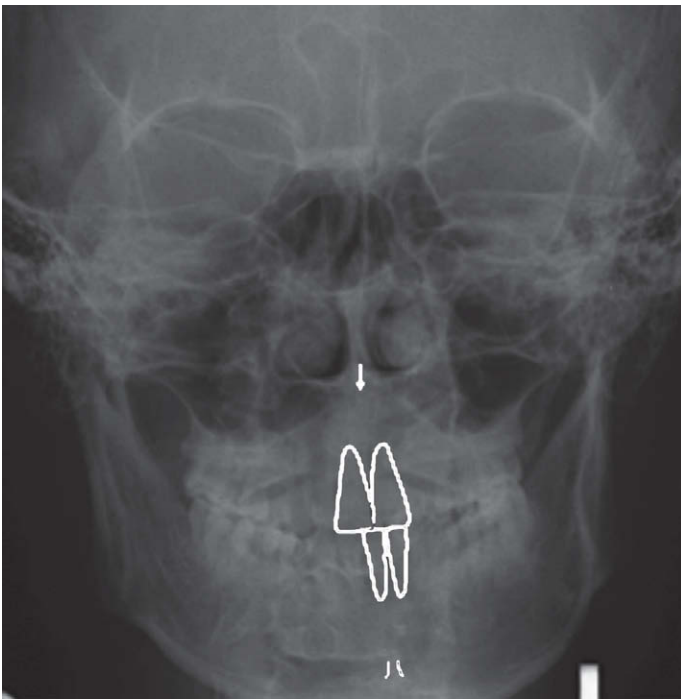


Fig. 6.186

The PA cephalogram showed the mandible deviated to the left with an asymmetric mandibular border. The lower dental midline deviation was also seen (Fig. 6.186).

Table 6.9 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	77.0
SNB (deg)	79.5
ANB (deg)	−2.5

Vertical

GoMe/SN (deg)	34.5
FMPA (deg)	29.0
PP/MP (deg)	21.0
Lower gonial (deg)	77.0
ANS–Me (mm)	76.0

DENTAL ANALYSIS

Overjet (mm)	−0.5
Overbite (mm)	0.0
UI/SN (deg)	109.5
L1/GoMe (deg)	99.5
SN/OP (deg)	19.5
Is–Is' (mm)	31.5
Mo–Ms (mm)	28.0
Ii–Ii' (mm)	47.0
Mo–Mi (mm)	41.0

LIP ANALYSIS

U Lip–E (mm)	−5.0
L Lip–E (mm)	1.0
NLA (deg)	91.0

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

Treatment objectives and plan

Treatment with extraction of the three third molars and miniscrew implant anchorage in the right retromolar area was planned to retract the lower teeth and at the same time correct the dental midline discrepancy.

Treatment

After extraction of the three third molars, the upper and lower arches were bonded with .022/.028 preadjusted fixed appliances. The arches were leveled and aligned and the archwires progressively increased

up to .019/.025 stainless steel working archwires. At 4 months into treatment, an ORLUS® miniscrew implant (diameter 1.6 mm, length 10.0 mm) was placed in the lower right retromolar area. The non-threaded part of the screw was 2.0 mm long and threaded part was 8.0 mm long. The length was selected on the basis of the thickness of the mucosa at the insertion site. The head of the miniscrew was exposed intraorally to facilitate open-pull force application (Figs 6.187, 6.188). One week after miniscrew insertion, a 200 g orthodontic force was applied by using medium force Sentalloy® coil springs (Figs 6.189, 6.190).

Total treatment time was 19 months.



Fig. 6.187

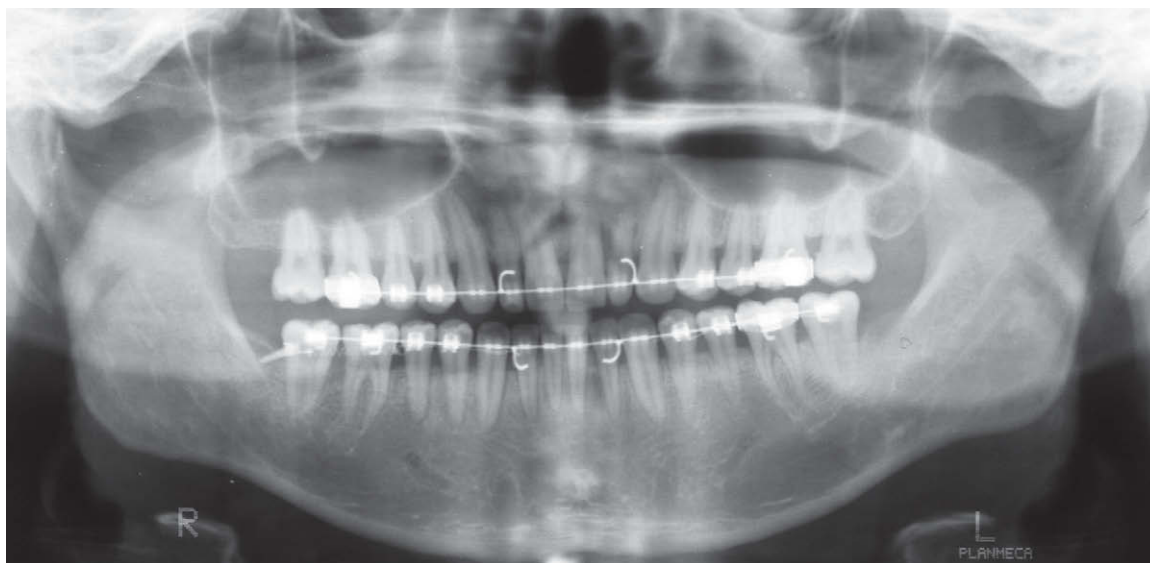


Fig. 6.188



Fig. 6.189



Fig. 6.190

Post-treatment evaluation

Lower lip protrusion reduced as the lower dentition had been retracted. The dental midlines were aligned. Super Class I canine and molar relationships were attained on both sides. The crossbite was corrected (Figs 6.191–6.198).

Uprighting of the molars was noted on the post-treatment panoramic radiograph. The horizontal alveolar bone level was maintained (Fig. 6.199).



Fig. 6.191



Fig. 6.192



Fig. 6.193



Fig. 6.194



Fig. 6.195



Fig. 6.196



Fig. 6.197



Fig. 6.198



Fig. 6.199

The pre- and post-treatment cephalometric superimpositions show retraction of the lower teeth. The difference in the anteroposterior position of the right and left molar teeth decreased following treatment as the lower right molar, which had been more anteriorly positioned initially, was retracted. The lower incisors were retracted by 3.0 mm and retroclined 8.5° . Intrusion of the lower incisor and molars,

0.7 mm and 1.7 mm, respectively, was noted because the retraction force on the lower teeth was applied from retromolar miniscrews at the level of the gingiva. Minimal movement was seen in the upper teeth. A slight increase in upper incisor proclination and slight decrease in the facial height was noted (Figs 6.200–6.203; Table 6.10).



Fig. 6.200

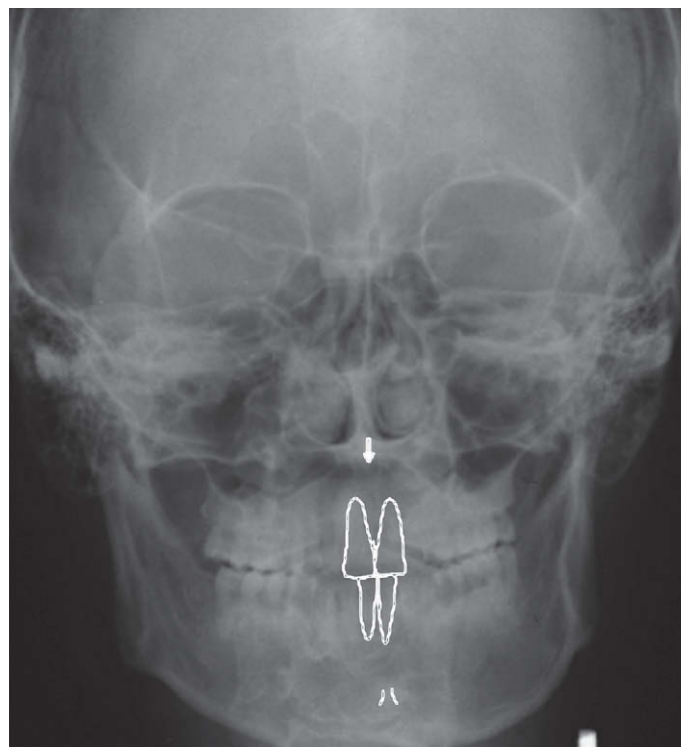


Fig. 6.201

Clinical tip

Depending on the soft tissue thickness, the closed-pull method (Figure 6.174) or open-pull method (Figure 6.175) can be used in the retromolar pad area. See Chapter 5 for a detailed description of the methods.

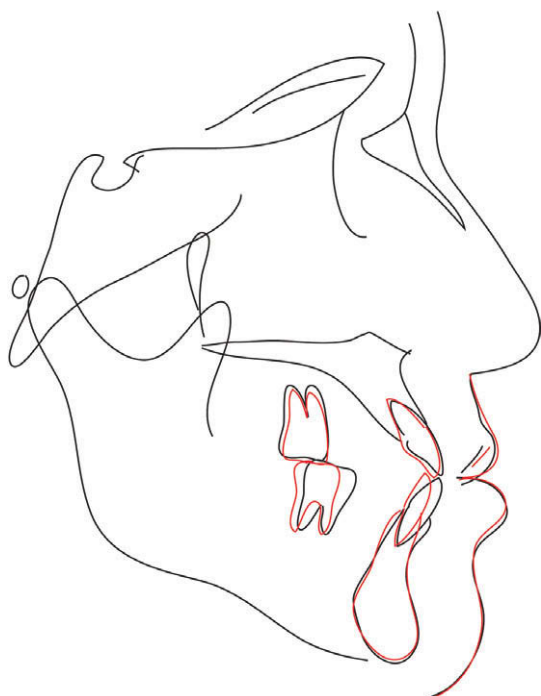


Fig. 6.202

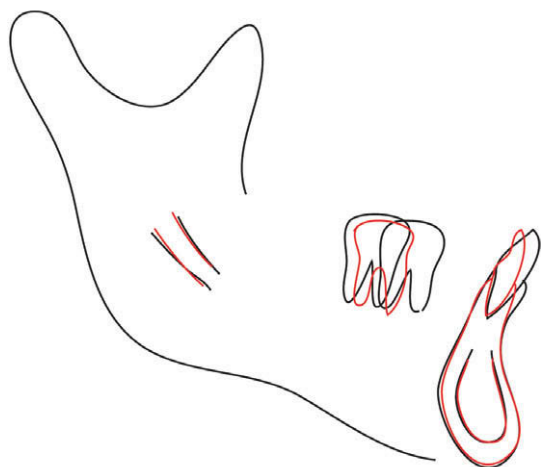
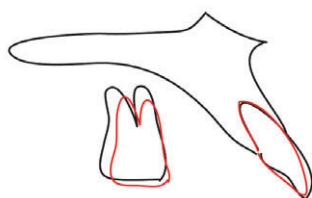


Fig. 6.203

Table 6.10 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	77.0	78.0
SNB (deg)	79.5	79.5
ANB (deg)	-2.5	-1.5
Vertical		
GoMe/SN (deg)	34.5	32.0
FMPA (deg)	29.0	29.0
PP/MP (deg)	21.0	20.0
Lower gonial (deg)	77.0	76.0
ANS-Me (mm)	76.0	75.0
DENTAL ANALYSIS		
Overjet (mm)	-0.5	2.0
Overbite (mm)	0.0	0.5
UI/SN (deg)	109.5	111.5
L1/GoMe (deg)	99.5	91.0
SN/OP (deg)	19.5	18.0
Is-Is' (mm)	31.5	31.0
Mo-Ms (mm)	28.0	28.0
li-li' (mm)	47.0	46.5
Mo-Mi (mm)	41.0	40.0
LIP ANALYSIS		
U Lip-E (mm)	-5.0	-4.0
L Lip-E (mm)	1.0	0.0
NLA (deg)	91.0	80.0

See page ix for Korean norms.

See Table 6.1 and page x for abbreviations.

MINISCREW IMPLANT ANCHORAGE FOR MOLAR DISTALIZATION

Molar distalization as part of en-masse retraction of all upper teeth has been discussed and illustrated above. Miniscrews can also provide excellent and convenient anchorage when the upper arch is distalized in two stages. A variety of intraoral appliances based on palatal anchorage have been successful in distalizing upper molars. Commonly used appliances are the distal jet and pendulum appliances. However, the initial gain in molar retraction is inevitably associated with mesial movement of the anterior anchor teeth and much of the initial molar improvement is lost during the course of subsequent retraction of these anterior teeth. Interarch elastics, for example with sliding jigs and class II elastic force to the posterior segment of the maxillary arch, or extraoral anchorage, such as headgear can be used, but both methods rely heavily on patient cooperation. Moreover, use of class II elastics

causes anchorage loss in the lower arch. The key to success is a force system that distalizes the molars and then the more anterior teeth without reciprocal protrusion of the anterior teeth and without requiring patient cooperation. With miniscrew anchorage, these twin goals of no loss of anchorage and no need for patient cooperation can be realized. This section will describe three different generic miniscrew applications for molar distalization:

- Use of miniscrew implants as direct anchors to retract the anterior teeth after molar distalization (Case 6.6)
- Use of miniscrew implants as indirect anchors to hold the molars in position while the anterior teeth are retracted (Case 6.7 and 6.8)
- Use of miniscrew implants as indirect anchors to secure the anchorage unit during molar distalization (Case 6.8)

CASE 6.6

Retraction of anterior teeth after molar distalization with the pendulum appliance in an adult patient with Class II malocclusion

Presenting complaint and clinical examination

An 18-year-old Korean woman presented with lip protrusion. There was minor upper and lower anterior crowding with bilateral Class I molar relationship (Figs 6.204, 6.205; Table 6.11).



Fig. 6.204



Fig. 6.205

Table 6.11 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	78.0
SNB (deg)	75.0
ANB (deg)	4.0

Vertical

GoMe/SN (deg)	40.0
FMPA (deg)	28.0
PP/MP (deg)	24.0
Lower gonial (deg)	78.0
ANS–Me (mm)	73.0

DENTAL ANALYSIS

Overjet (mm)	4.8
Overbite (mm)	2.2
UI/SN (deg)	110.5
L1/GoMe (deg)	101.0
SN/OP (deg)	22.0
Is–Is' (mm)	32.0
Mo–Ms (mm)	27.5
li–li' (mm)	48.0
Mo–Mi (mm)	38.0

LIP ANALYSIS

U Lip–E (mm)	2.1
L Lip–E (mm)	3.4
NLA (deg)	82.0

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

Treatment plan

The patient refused extraction treatment. Therefore, molar distalization with the pendulum appliance was planned.

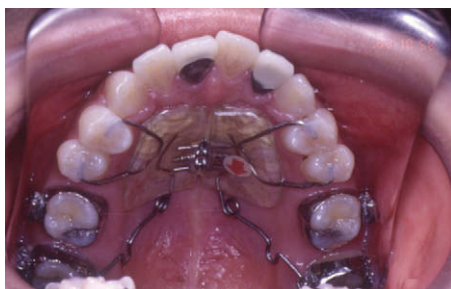


Fig. 6.206

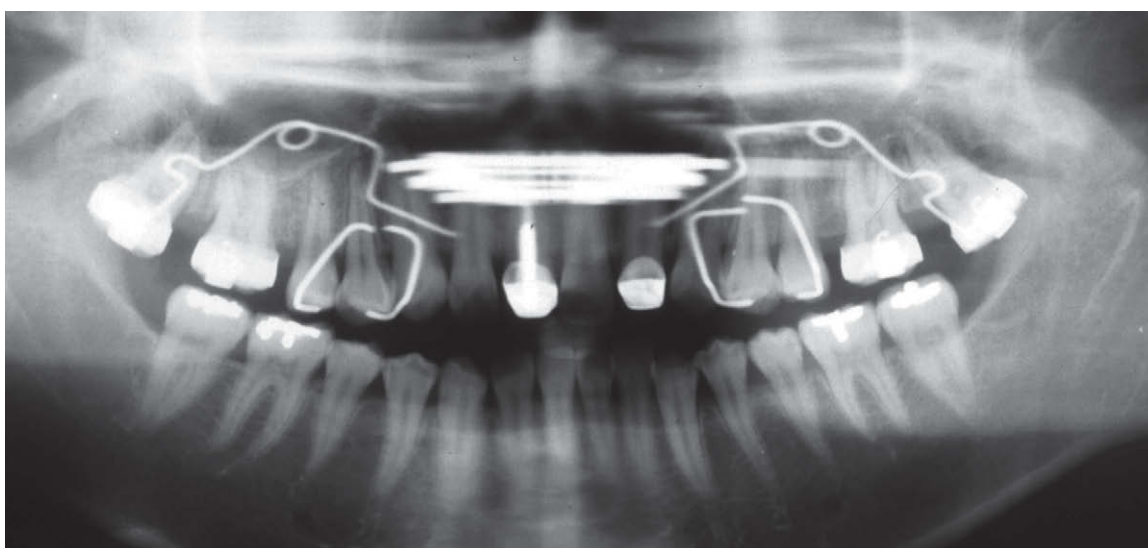


Fig. 6.207



Fig. 6.208

Treatment

In the first phase of treatment, after 5 months of second molar distalization (Figs 6.206, 6.207), the appliance was removed. A Nance holding arch was cemented to the upper second molars and bonded to the first premolars while the first molars and second premolars were retracted (Fig. 6.208).

Miniscrew implant anchorage and further treatment

After the second premolars had been retracted, two Martin® miniscrews (diameter 1.6 mm, length 6.0 mm) were placed in the buccal alveolar inter-radicular bone between the second premolars and first molars. Root proximity was checked on a panoramic radiograph before placement. A manual screwdriver (hand driver)

was used for placement. Then the upper and lower teeth were bonded with .022/.028 preadjusted fixed appliances, and leveling and aligning was started (Figs 6.209–6.211). The anterior teeth and the first premolars were retracted against the miniscrew implants. Thus there was no anchorage strain on the second premolars and molars (Figs 6.212, 6.213) during this second phase of treatment.

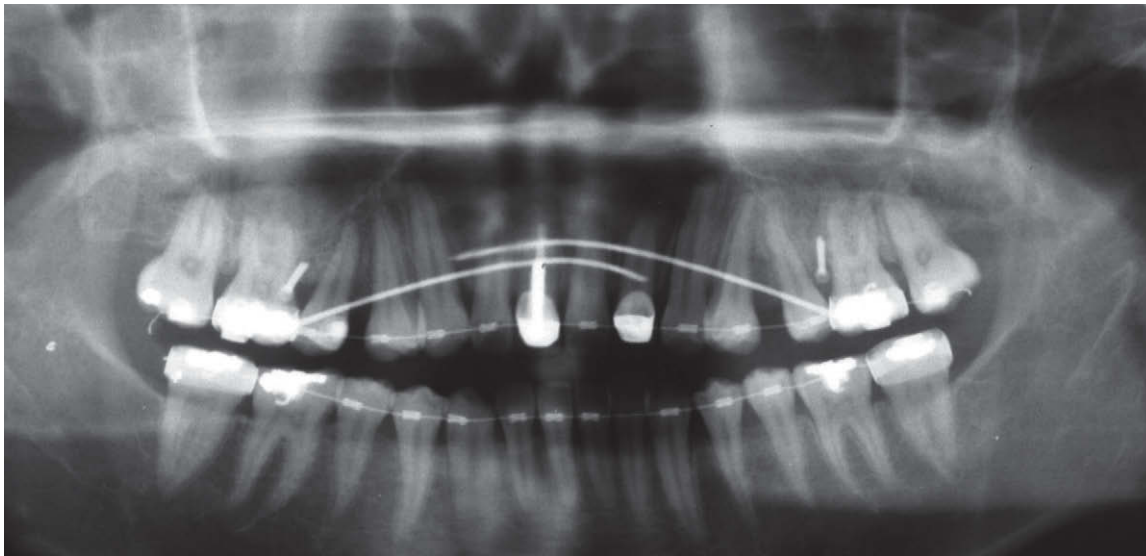


Fig. 6.209



Fig. 6.210



Fig. 6.211

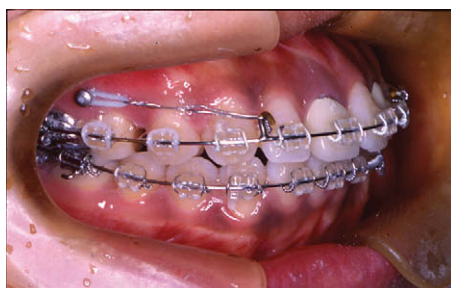


Fig. 6.212

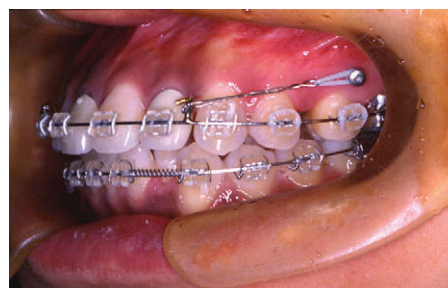


Fig. 6.213

Post-treatment evaluation

After bracket removal, superimposition of the pre- and post-treatment cephalometric tracings showed 2.5 mm distal movement of molars. The upper incisors were retracted by 4.0 mm and their labial inclination was

reduced. The lower incisors were retracted by 2.0 mm. There was some extrusion of the lower molars (Figs 6.214–6.218; Table 6.12).



Fig. 6.214



Fig. 6.215

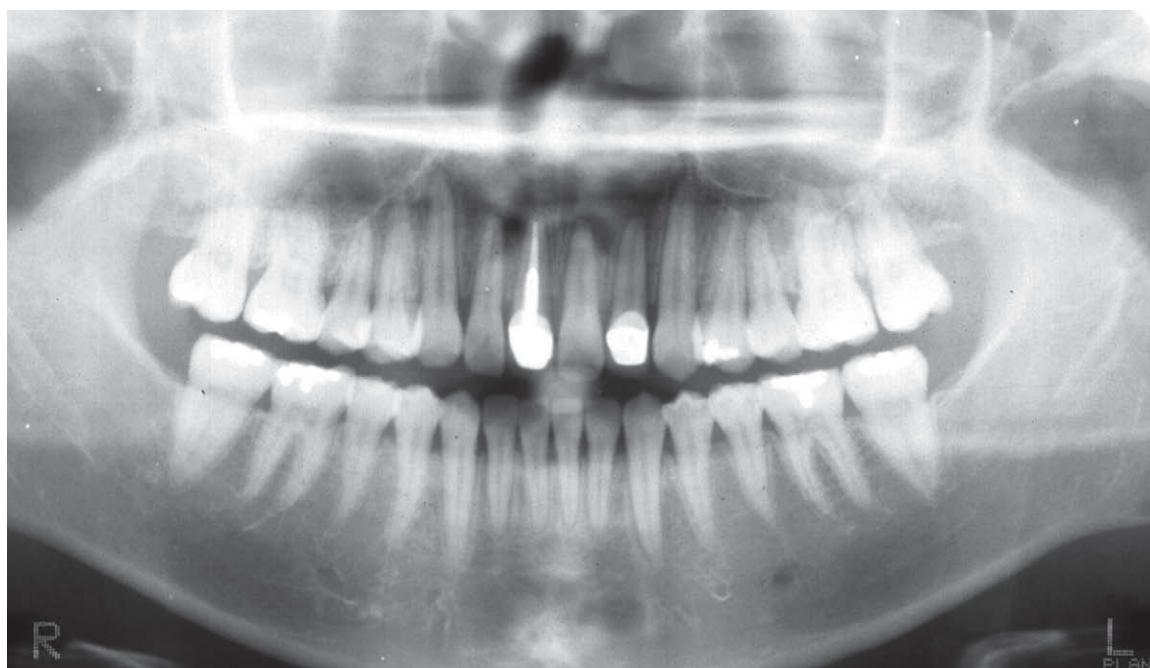


Fig. 6.216

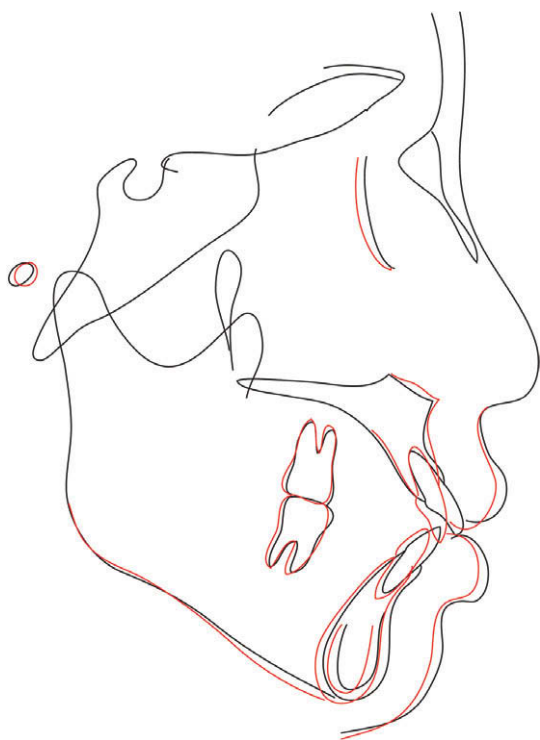


Fig. 6.217

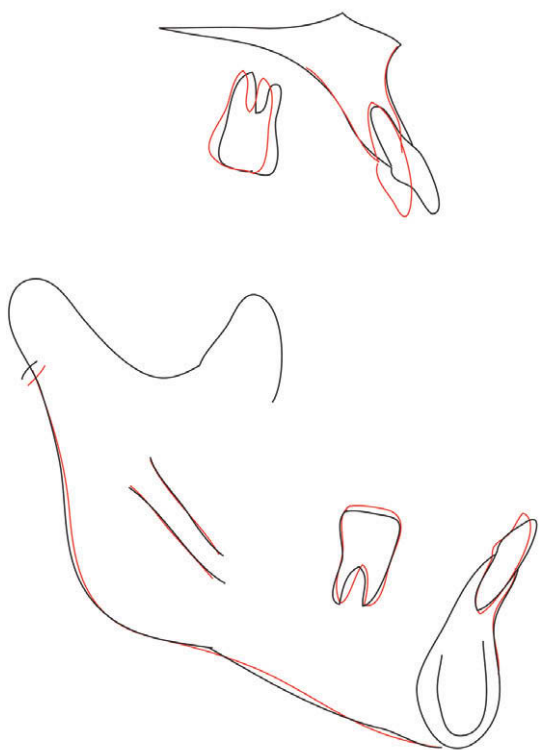


Fig. 6.218

Table 6.12 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	78.0	79.0
SNB (deg)	75.0	74.0
ANB (deg)	4.0	5.0
Vertical		
GoMe/SN (deg)	40.0	42.0
FMPA (deg)	28.0	31.0
PP/MP (deg)	24.0	27.0
Lower gonial (deg)	78.0	80.0
ANS–Me (mm)	73.0	73.5
DENTAL ANALYSIS		
Overjet (mm)	4.8	3.0
Overbite (mm)	2.2	3.0
UI/SN (deg)	110.5	94.0
L1/GoMe (deg)	101.0	95.0
SN/OP (deg)	22.0	22.5
Is–Is' (mm)	32.0	33.5
Mo–Ms (mm)	27.5	27.0
li–li' (mm)	48.0	48.5
Mo–Mi (mm)	38.0	40.0
LIP ANALYSIS		
U Lip–E (mm)	2.1	1.5
L Lip–E (mm)	3.4	3.4
NLA (deg)	82.0	95.0

See page ix for Korean norms.

See Table 6.1 and page x for abbreviations.

CASE 6.7

Reinforcement of posterior anchorage after molar distalization in an adolescent patient

Presenting complaint and clinical examination

A 13-year-old Korean boy presented with the chief complaint of a high left upper canine. The skeletal pattern was Class I. The upper left canine was erupting buccally and was blocked out of the arch. The upper dental midline was deviated to the left side and lower dental midline was correct. There was an anterior

open bite with normal upper and lower incisor axial inclinations. There was minor lower anterior crowding (Figs 6.219–6.223; Table 6.13).

Treatment objectives and plan

Non-extraction treatment with molar distalization using the pendulum appliance was planned.



Fig. 6.219



Fig. 6.220



Fig. 6.221



Fig. 6.222



Fig. 6.223

Table 6.13 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	81.0
SNB (deg)	77.0
ANB (deg)	4.0

Vertical

GoMe/SN (deg)	39.0
FMPA (deg)	31.0
PP/MP (deg)	25.0
Lower gonial (deg)	82.0
ANS–Me (mm)	74.8

DENTAL ANALYSIS

Overjet (mm)	1.0
Overbite (mm)	–1.3
UI/SN (deg)	106.5
L1/GoMe (deg)	93.0
SN/OP (deg)	19.0
Is–Is' (mm)	31.0
Mo–Ms (mm)	27.8
Ii–Ii' (mm)	47.0
Mo–Mi (mm)	38.0

LIP ANALYSIS

U Lip–E (mm)	1.0
L Lip–E (mm)	4.5
NLA (deg)	86.5

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

Treatment

After 3 months the upper first molars were distalized (Fig. 6.224). The pendulum appliance was removed and replaced with a transpalatal arch with a hook soldered in the center. An OsteoMed® miniscrew implant (diameter 1.6 mm, length 6.0 mm) was placed in the midpalatal region level with the first molars anteroposteriorly. A chain was attached to the hook on the transpalatal arch and the miniscrew to apply distal traction. All the upper teeth except the left canine were bonded with .022/.028 preadjusted brackets and distalization of the upper premolars initiated (Figs 6.225–6.228).

As the molars were held distally with the miniscrew implant anchorage, they were not expected to move mesially while the premolars were being distalized into the space gained. The left canine was bonded after space was available for its alignment in the arch (Fig. 6.229).

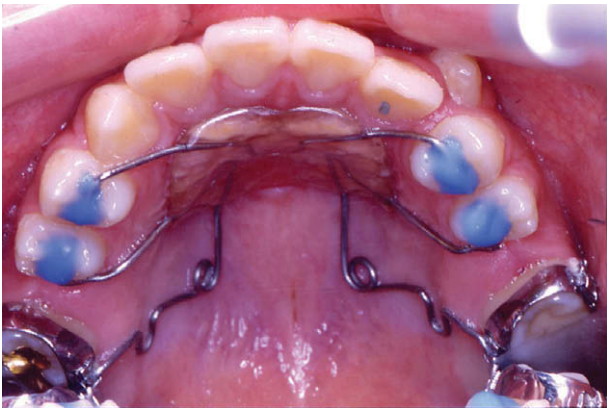


Fig. 6.224

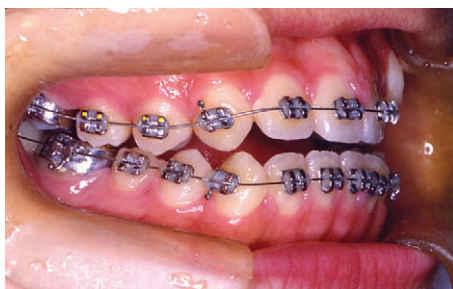


Fig. 6.225



Fig. 6.226



Fig. 6.227



Fig. 6.228

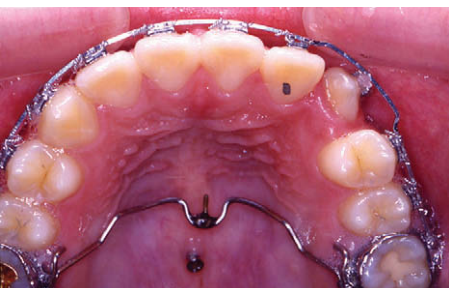


Fig. 6.229



Fig. 6.230



Fig. 6.231



Fig. 6.232

Post-treatment evaluation

The upper and lower dental midlines were aligned and the upper left canine was well positioned into the arch although vertical control was not sufficient in this case (Figs 6.230–6.234; Table 6.14).

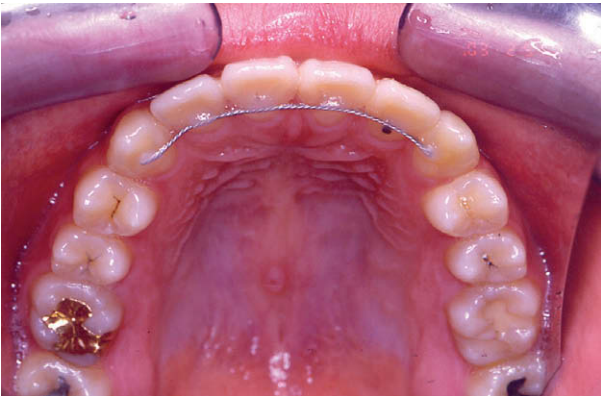


Fig. 6.233

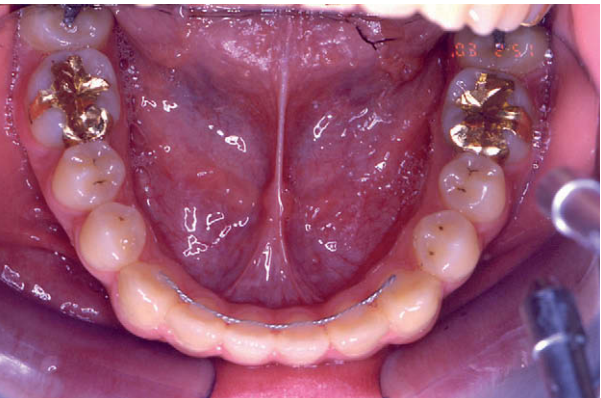


Fig. 6.234

Table 6.14 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	81.0	84.0
SNB (deg)	77.0	79.0
ANB (deg)	4.0	5.0
Vertical		
GoMe/SN (deg)	39.0	37.5
FMPA (deg)	31.0	31.0
PP/MP (deg)	25.0	27.5
Lower gonial (deg)	82.0	83.0
ANS–Me (mm)	74.8	80.5
DENTAL ANALYSIS		
Overjet (mm)	1.0	2.0
Overbite (mm)	–1.3	0.5
UI/SN (deg)	106.5	111.5
L1/GoMe (deg)	93.0	80.5
SN/OP (deg)	19.0	20.0
Is–Is' (mm)	31.0	34.0
Mo–Ms (mm)	27.8	27.5
li–li' (mm)	47.0	50.0
Mo–Mi (mm)	38.0	41.5
LIP ANALYSIS		
U Lip–E (mm)	1.0	0.5
L Lip–E (mm)	4.5	5.0
NLA (deg)	86.5	79.0

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

CASE 6.8

Reinforcement of anchorage in both phases of upper arch distalization in a growing patient with a Class II malocclusion

Presenting complaint and clinical examination

A 13-year-old Korean boy presented with severe upper anterior crowding and upper lip protrusion. Both upper canines were blocked buccally and the molar relationship was Class II bilaterally. The upper incisors were retroclined and the lower incisors were proclined with an overjet of 3.0 mm and overbite of 3.5 mm.

There was a midline discrepancy (Figs 6.235–6.240; Table 6.15).

Treatment objectives and plan

The patient's parents requested non-extraction treatment. Molar distalization was planned to gain space for relief of anterior crowding.



Fig. 6.235



Fig. 6.236



Fig. 6.237



Fig. 6.238

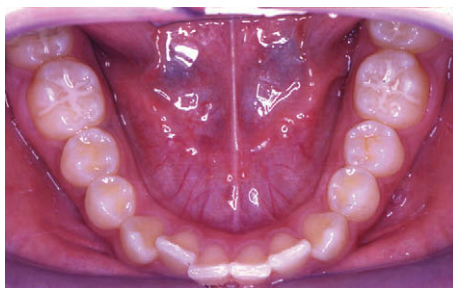


Fig. 6.239

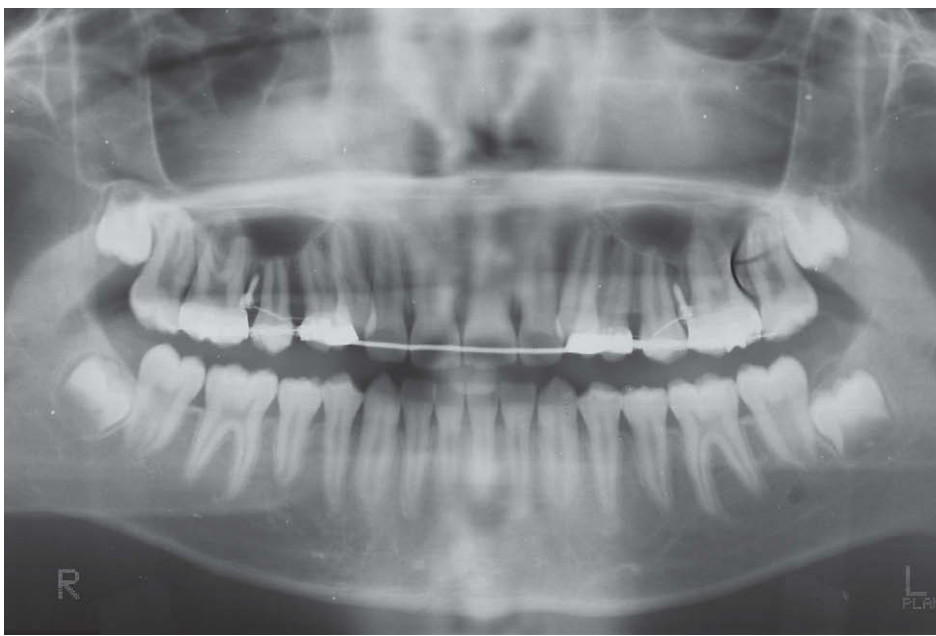


Fig. 6.240

Table 6.15 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	80.0
SNB (deg)	75.0
ANB (deg)	5.0

Vertical

GoMe/SN (deg)	34.5
FMPA (deg)	23.5
PP/MP (deg)	25.0
Lower gonial (deg)	71.0
ANS–Me (mm)	71.0

DENTAL ANALYSIS

Overjet (mm)	3.0
Overbite (mm)	3.5
UI/SN (deg)	95.0
L1/GoMe (deg)	102.0
SN/OP (deg)	24.0
Is–Is' (mm)	34.0
Mo–Ms (mm)	26.0
Ii–Ii' (mm)	43.0
Mo–Mi (mm)	35.5

LIP ANALYSIS

U Lip–E (mm)	4.0
L Lip–E (mm)	4.2
NLA (deg)	71.5

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

Treatment

Two OSAS® miniscrews (diameter 1.6 mm, length 6.0 mm) were placed in the buccal alveolar inter-radicular bone between the upper second premolars and first molars. Root proximity was checked on a panoramic radiograph prior to placement. A manual screwdriver (hand driver) was used for placement. Periapical radiographs were taken after placement to verify the absence of miniscrew–root contact (Figs 6.241, 6.242).



Fig. 6.241



Fig. 6.242

In the following week, a palatal arch was cemented to the upper first premolars. The miniscrew implants were connected passively to this with steel ligature wires to negate the reciprocal forces produced by the push coil springs placed between the first premolars and first molars. Segmental .016/.022 stainless steel wires were

engaged in the brackets and nickel-titanium open coil springs were placed to distalize the first molars (Figs 6.243–6.246). A panoramic radiograph was taken to check any miniscrew contact with second premolars (Fig. 6.247). Molar distalization was continued and the second premolars drifted distally as well (Fig. 6.248).



Fig. 6.243



Fig. 6.244



Fig. 6.245



Fig. 6.246

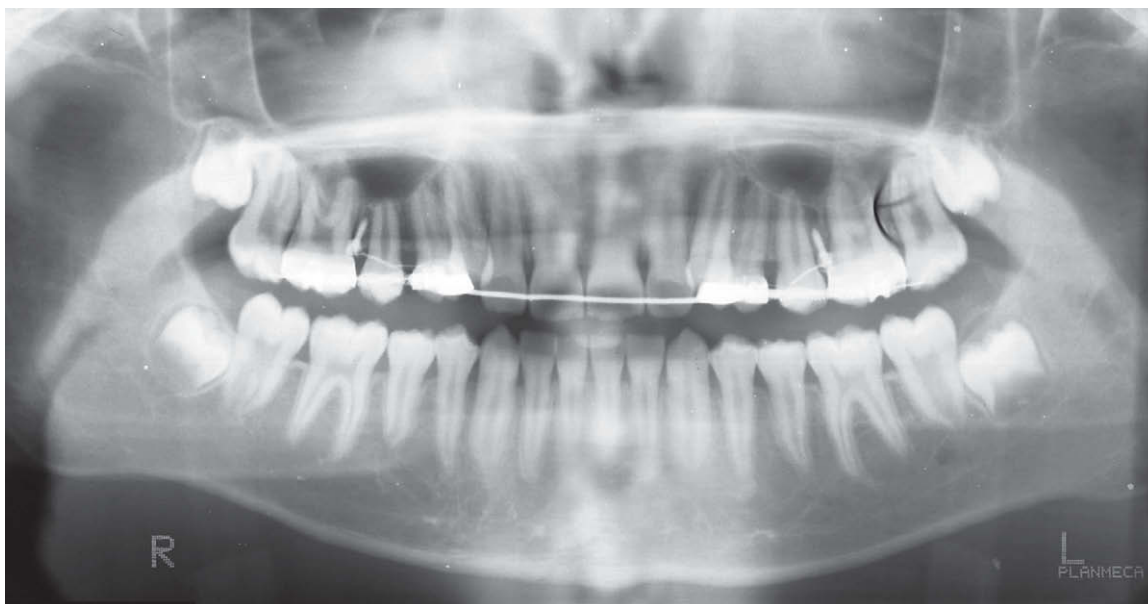


Fig. 6.247

After 12 months, sufficient arch length was gained with minimal change in the anterior dentition (Figs 6.249–6.251).

Another panoramic radiograph was taken (Fig 6.252). The second premolars were near the miniscrews and so molar distalization was stopped.



Fig. 6.248



Fig. 6.249



Fig. 6.250



Fig. 6.251



Fig. 6.252

The lingual arch was removed and a transpalatal arch, with a hook soldered in the center to facilitate elastic chain application, was fitted on the first molars. The buccal alveolar miniscrew implants were removed under topical anesthesia. Under infiltrative anesthesia, another OSAS® miniscrew implant (diameter 1.6 mm, length 6.0 mm) was placed in the midpalatal region level with first molars anteroposteriorly. The upper anterior teeth and all lower teeth were bonded with .022/.028 preadjusted fixed appliances. Distal traction was applied between the transpalatal bar and the miniscrew to prevent the molars from moving mesially. The archwires were engaged in the canines from the start of this phase (Figs 6.253–6.257).

Archwire size was progressively increased and the chain between the transpalatal arch hook and

the miniscrew implant was replaced regularly to continuously refresh the intrusive and retractive force on the molars (Fig. 6.258).

Post-treatment evaluation

An ‘over-corrected’ Class I molar relationship was attained (Figs 6.259–6.263). Superimposition of the pre- and post-treatment cephalometric tracings showed 2.5 mm bodily distal movement and 1.0 mm intrusion of the upper molars. Eruption of lower molars was seen. There was favorable downward and forward mandibular growth during the treatment with proclination of the upper and lower incisors (Figs 6.264–6.266; Table 6.16).



Fig. 6.253



Fig. 6.254



Fig. 6.255

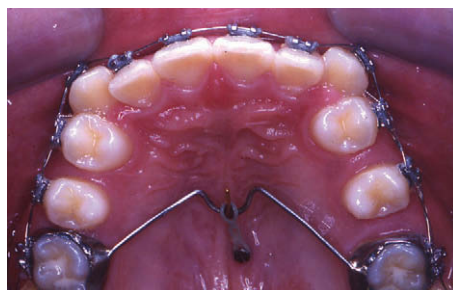


Fig. 6.256

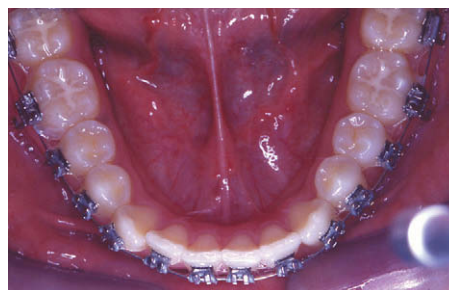
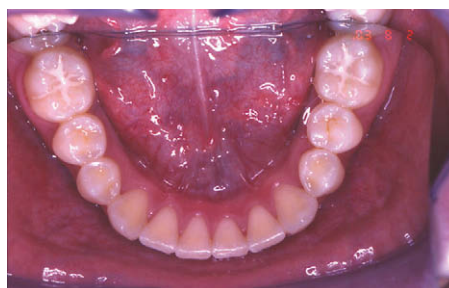


Fig. 6.257



Fig. 6.258

**Fig. 6.259****Fig. 6.260****Fig. 6.261****Fig. 6.262****Fig. 6.263****Fig. 6.264**

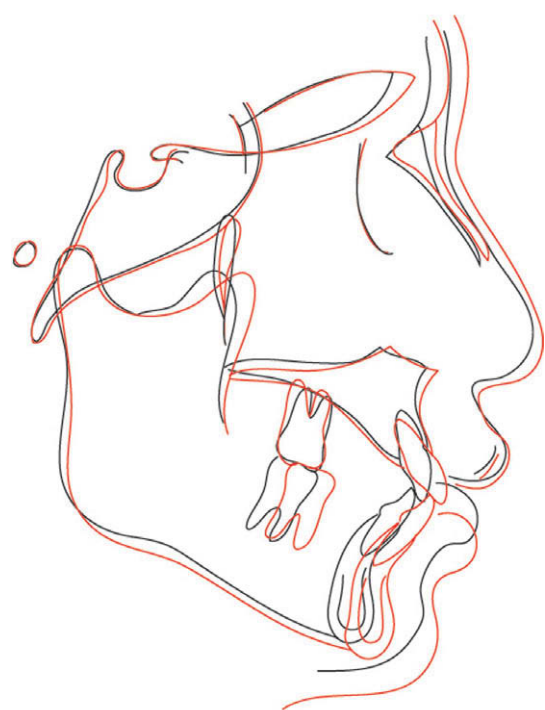


Fig. 6.265

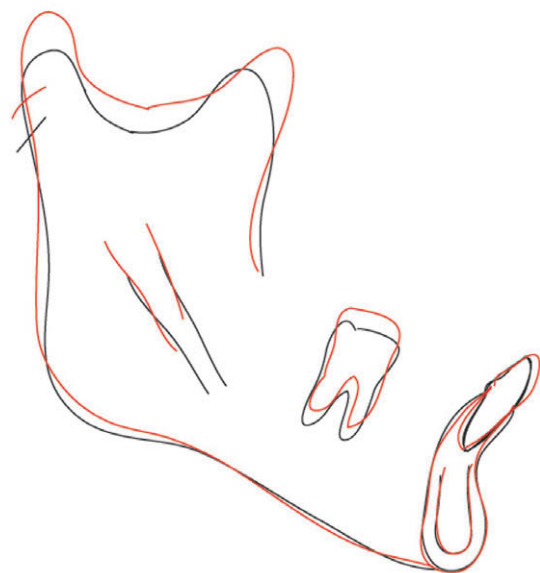
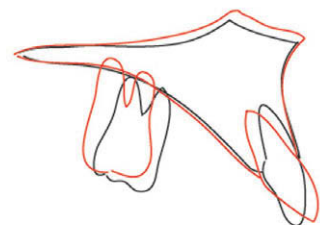


Fig. 6.266

Table 6.16 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	80.0	78.0
SNB (deg)	75.0	74.5
ANB (deg)	5.0	3.5
Vertical		
GoMe/SN (deg)	34.5	34.0
FMPA (deg)	23.5	22.5
PP/MP (deg)	25.0	26.0
Lower gonial (deg)	71.0	71.0
ANS–Me (mm)	71.0	72.5
DENTAL ANALYSIS		
Overjet (mm)	3.0	2.5
Overbite (mm)	3.5	2.0
UI/SN (deg)	95.0	108.0
L1/GoMe (deg)	102.0	106.0
SN/OP (deg)	24.0	24.0
Is–Is' (mm)	34.0	34.0
Mo–Ms (mm)	26.0	24.5
li–li' (mm)	43.0	44.0
Mo–Mi (mm)	35.5	38.0
LIP ANALYSIS		
U Lip–E (mm)	4.0	1.3
L Lip–E (mm)	4.2	2.0
NLA (deg)	71.5	73.0

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

Intraoral photographs taken 2 years after treatment showed minimal post-treatment changes (Figs 6.267–6.269).



Fig. 6.267



Fig. 6.268



Fig. 6.269

MINISCREW IMPLANT ANCHORAGE FOR ANTERIOR MOVEMENT OF POSTERIOR TEETH

Mesial movement of teeth is generally easier than distal movement. However, mesial movement of posterior teeth without reciprocal retraction of anterior teeth is not so easy. There are several methods for reinforcing the anchorage unit – the anterior teeth. One way is to incorporate as many teeth as possible in the anterior anchor unit. Other ways include applying lingual/palatal root torque to the incisor teeth and extraoral

traction using a facemask to apply a mesially directed force.

With miniscrew implants, such methods of anchorage reinforcement are unnecessary. Treatment mechanics are simplified and the treatment is not dependent on patient compliance.

CASE 6.9

Mesial movement of the posterior teeth in a patient with skeletal Class I malocclusion and facial asymmetry

Presenting complaint and clinical examination

A 27-year-old Korean woman presented with the chief complaint of lip protrusion and asymmetry. On examination, her face was asymmetric with the mandible deviated to the left. Her lips were canted and

the left corner of her mouth was higher than the right. Her lips were protrusive and slight mentalis strain was seen on lip closure (Figs 6.270–6.273). She had clicking in both temporomandibular joints since the past 7 years, but with no pain.



Fig. 6.270



Fig. 6.271



Fig. 6.272



Fig. 6.273

Intraoral examination showed Class III canine and molar relationships on the right side and Class I canine and molar relationships on the left side. She had no overjet and 1.0 mm overbite. The upper laterals were in crossbite with the lower canines and there was a unilateral posterior crossbite on left side as the mandible shifted to the same side. The upper

dental midline was centered within the face but the lower dental midline was 4.0 mm to the left. There was minor upper and lower anterior crowding. Given the morphology of the crowns of the upper molars, congenital absence of the upper first molars was suspected (Figs 6.274–6.279).



Fig. 6.274



Fig. 6.275



Fig. 6.276



Fig. 6.277

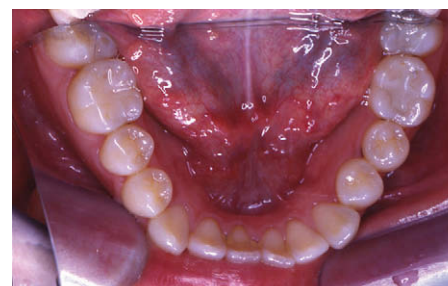


Fig. 6.278



Fig. 6.279

Radiographic evaluation

The panoramic radiograph revealed a full complement of teeth apart from a missing molar in each quadrant (Fig. 6.280). Cephalometric analysis revealed a skeletal Class I relationship. The upper incisors had normal axial inclination and the lower incisors were proclined. The lips were protrusive relative to the E line (Fig. 6.281; Table 6.17). The PA cephalogram showed deviation of the mandible to the left with a canted maxilla (Fig. 6.282).

Treatment objectives and plan

The patient did not want to undergo surgical treatment. Extraction of the upper second premolars was planned because the upper incisors had normal inclinations and the lips were mildly protrusive. In the lower arch, asymmetric extraction – the right first premolar and the left second premolar – was planned for retraction of the lower anterior teeth and midline correction. A transpalatal arch would be used to increase intermolar width for correcting the posterior crossbite. The skeletal asymmetry would be maintained.



Fig. 6.280



Fig. 6.281



Fig. 6.282

Table 6.17 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	82.0
SNB (deg)	80.0
ANB (deg)	2.0

Vertical

GoMe/SN (deg)	31.0
FMPA (deg)	23.0
PP/MP (deg)	19.0
Lower gonial (deg)	72.0
ANS–Me (mm)	69.0

DENTAL ANALYSIS

Overjet (mm)	0.0
Overbite (mm)	1.0
UI/SN (deg)	99.5
L1/GoMe (deg)	99.0
SN/OP (deg)	20.0
Is–Is' (mm)	30.0
Mo–Ms (mm)	25.0
li–li' (mm)	43.0
Mo–Mi (mm)	38.0

LIP ANALYSIS

U Lip–E (mm)	0.0
L Lip–E (mm)	3.0
NLA (deg)	97.5

See page ix for Korean norms.
See Table 6.1 and page x for abbreviations.

At the treatment consultation, the patient requested to have the upper right first premolar extracted as it had undergone previous root canal treatment and crown restoration. The treatment plan was modified with extraction of both upper first premolars instead of the second premolars. This change of extraction diminished the available anterior anchorage, so it was planned to place a miniscrew in the midpalatal suture area level with the first premolars anteroposteriorly to provide anchorage for anterior movement of the upper posterior teeth.

Treatment

After extraction of the upper first premolars and lower right first premolar and left second premolar, a transpalatal arch was fitted, having been expanded before cementation. The upper and lower teeth were bonded with .022/.028 preadjusted fixed appliances, and leveling and aligning begun.

Miniscrew implant anchorage and further treatment

Four months into treatment, an upper .019/.025 stainless steel archwire was inserted. An OsteoMed® miniscrew implant (diameter 1.6 mm, length 6.0 mm) was placed in the midpalatal suture area under infiltrative anesthesia. Before the procedure, the vertical bone height of the palatal suture area was assessed on the lateral cephalogram to determine the appropriate implant length. Anteroposteriorly, the midpalatal miniscrew implant was placed level with the first premolars so that adequate distance was available for traction. There are no roots, nerves or blood vessels in this area to complicate the implant placement. An elastic chain was attached from the miniscrew to the transpalatal arch to move the upper molars mesially. The transpalatal arch was fabricated so that it was inserted from the distal to mesial direction in the lingual sheaths to prevent it from loosening as traction was applied (Figs 6.283–6.288).

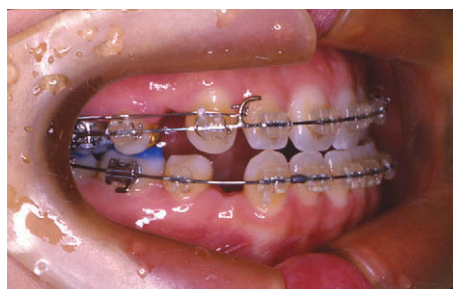


Fig. 6.283



Fig. 6.284

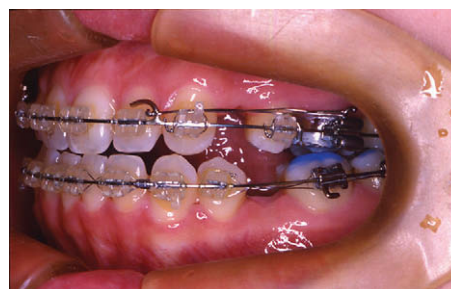


Fig. 6.285



Fig. 6.286

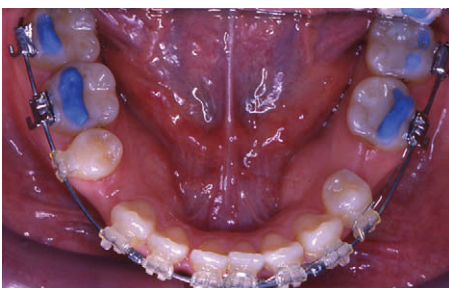


Fig. 6.287

Mesial movement of the posterior teeth was continued by replacing the chain at each visit for the next 4 months. No retraction force was applied to the upper anterior teeth. Passive tiebacks were placed in the upper arch. A .019/.025 stainless steel archwire was engaged in the lower arch and space closure started with active tiebacks from the anterior hooks on the archwire to the second molar attachment hooks. The distance between the miniscrew implant and the transpalatal arch started to decrease as the molars moved mesially (Figs 6.289–6.291).

As the lower midline was being corrected (Fig. 6.292), the design of the transpalatal arch needed to be altered so that adequate distance from the miniscrew implant was again available for chain application (Fig. 6.293). The implants were stable throughout the treatment.

The total active treatment time was 19 months.



Fig. 6.288



Fig. 6.289



Fig. 6.290



Fig. 6.291



Fig. 6.292



Fig. 6.293

Post-treatment evaluation

There was an improvement in the profile. Lip protrusion was reduced and the mentalis strain had disappeared. The chin appeared prominent due to retraction of

the lower anterior teeth. Mandible asymmetry was still present, as the patient had been informed prior to treatment (Figs 6.294–6.297).



Fig. 6.294



Fig. 6.295



Fig. 6.296



Fig. 6.297

The lower midline was still off by 1.0 mm, but the upper and lower axial inclinations had improved. Class I canine and molar relationships were established on the right side, but a Class III molar relationship was seen on the left side. The anterior crossbite and the left posterior crossbite had been corrected (Figs 6.298–6.303).

The post-treatment panoramic radiograph showed that bone level was maintained with slight apical root resorption in the upper and lower incisors (Fig. 6.304).



Fig. 6.298



Fig. 6.299



Fig. 6.300



Fig. 6.301

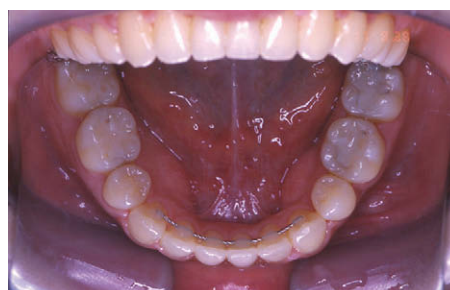


Fig. 6.302



Fig. 6.303



Fig. 6.304

Superimposition of the pre- and post-treatment cephalometric tracings showed retrusion of the upper and lower lips. The upper incisors were retracted by 3.5 mm with 5.0° reduction in labial inclination. The



Fig. 6.305

upper molars had moved forward by 5.0 mm and the lower incisors were retracted by 6.0 mm with 14.0° reduction in labial inclination. The lower molars moved forward by 1.0 mm (Figs 6.305–6.307; Table 6.18).

Table 6.18 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements			
	Pretreatment		Post-treatment
SKELETAL ANALYSIS			
Anteroposterior			
SNA (deg)	82.0		83.0
SNB (deg)	80.0		79.0
ANB (deg)	2.0		4.0
Vertical			
GoMe/SN (deg)	31.0		31.0
FMPA (deg)	23.0		23.0
PP/MP (deg)	19.0		17.0
Lower gonial (deg)	72.0		71.0
ANS–Me (mm)	69.0		68.0
DENTAL ANALYSIS			
Overjet (mm)	0.0		3.3
Overbite (mm)	1.0		1.8
UI/SN (deg)	99.5		94.5
L1/GoMe (deg)	99.0		85.0
SN/OP (deg)	20.0		21.0
Is–Is' (mm)	30.0		29.0
Mo–Ms (mm)	25.0		25.5
li–li' (mm)	43.0		42.0
Mo–Mi (mm)	38.0		38.0
LIP ANALYSIS			
U Lip–E (mm)	0.0		–1.5
L Lip–E (mm)	3.0		0.5
NLA (deg)	97.5		91.0
See page ix for Korean norms. See Table 6.1 and page x for abbreviations.			

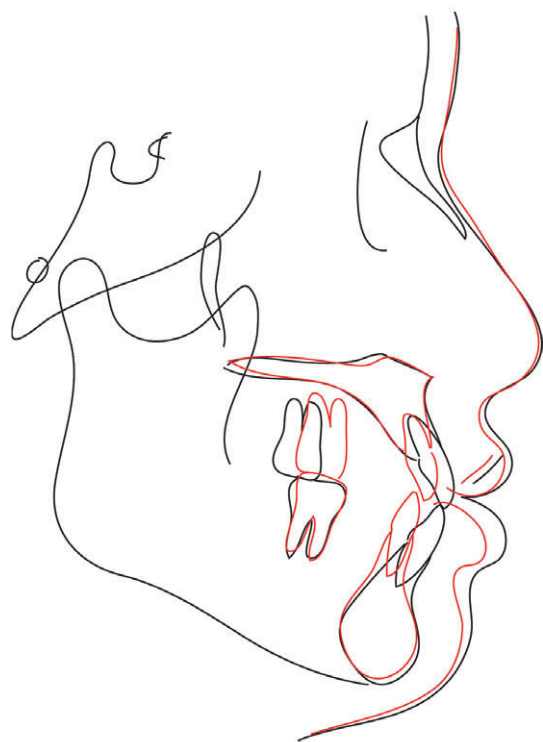


Fig. 6.306

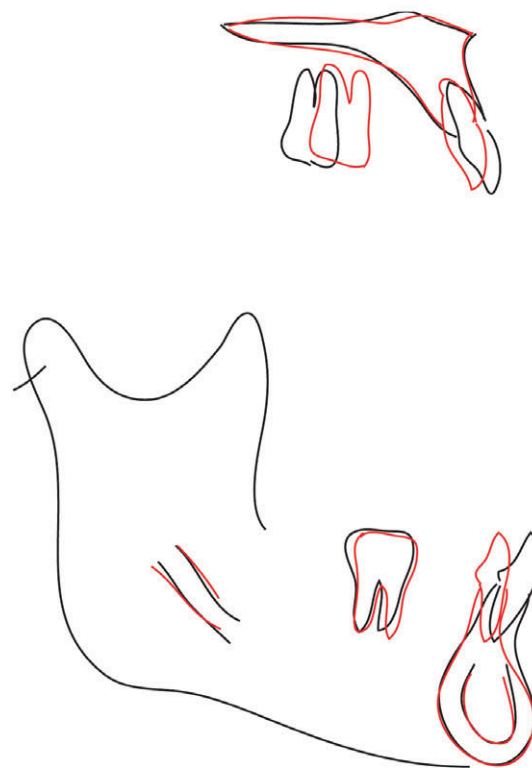


Fig. 6.307

At 3 years' and 2 months' follow-up, there were no remarkable changes in the facial esthetics and the occlusion (Figs 6.308–6.316).



Fig. 6.308



Fig. 6.309



Fig. 6.310



Fig. 6.311



Fig. 6.312



Fig. 6.313



Fig. 6.314



Fig. 6.315



Fig. 6.316

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MINISCREW IMPLANT ANCHORAGE FOR INTRUSION OF TEETH

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INTRODUCTION

Intrusion of posterior teeth is one of the most difficult orthodontic tooth movements. The reasons for this include dependence on patient cooperation, complicated appliance designs, inadequacy of available dental anchorage and unpredictable treatment and post-treatment response. These factors hold true for both growing and adult patients. However, these limitations can be overcome by the use of intraoral implants, and there are several situations where intrusion of groups of teeth is highly desirable.

INDICATIONS FOR INTRUSION

Miniscrew implant anchorage for intrusion of posterior teeth is indicated in patients with anterior open bite or vertical maxillary excess in whom reduction of lower anterior facial height is desirable. Intrusion may be attempted in either the upper or lower dentition, or both. In patients with severe anterior open bite, intrusion of both the upper and lower molars is advised. In patients in whom closure of the mandibular plane angle and reduction in anterior facial height are desirable, intrusion of the entire upper and lower dentitions is recommended. If intrusion is carried out in one arch only, compensating extrusion of posterior teeth in the opposing arch tends to negate the effect. As a result, there is little or no decrease in the mandibular plane angle or in the anterior facial height in spite of molar intrusion in one arch.

Two other factors should be considered when planning intrusion – the amount of upper incisor display in lip repose and the occlusal plane angle.

- Patients with reduced upper incisor show are not good candidates for intrusion of the upper teeth as that further reduces the incisor show. Inadequate upper incisor display in lip repose and while smiling can make a person look older.¹

- With a steep pretreatment occlusal plane, intrusion of the upper posterior teeth will lead to further steepening of the plane, which may not be compatible with the patient's condylar or incisal guidance. In such situations, intrusion of lower dentition is planned.

Three applications of miniscrew implant anchorage for intrusion are described in this chapter:

- Intrusion of the entire maxillary or mandibular dentitions either separately or simultaneously
- Intrusion of the posterior teeth in either arch
- Intrusion of anterior teeth

INTRUSION USING MINISCREWS

Intraoral endosseous implants of various kinds have been used as stationary anchorage to facilitate intrusive movement. Kanomi² reported on the use of mini-implants for intruding lower anterior teeth and molars, and Costa et al³ placed miniscrews in the region of the infrazygomatic ridge for use as orthodontic anchorage for intrusion of upper molar teeth. Sherwood et al⁴ and Umemori et al⁵ intruded upper and lower posterior teeth in patients with skeletal open bite using titanium miniplates as anchorage. Paik et al⁶ used midpalatal miniscrew implant anchorage to intrude the maxillary dentition in a patient with vertical maxillary excess. Sugawara et al⁷ intruded mandibular molars using miniplate anchorage, but noted a 27.2–30.3% relapse of this intrusion. Stability of intrusive movement has not yet been widely investigated and may conceivably be a significant problem.

Miniscrews are preferred to other types of implant because of ease of insertion and removal, fewest limitations with regard to insertion sites, less discomfort for the patient and lower associated costs. Other proposed advantages of miniscrew implants include greater stability, no need for flap surgery, a short healing period and immediate loading.

DESIGN OF THE APPLIANCE

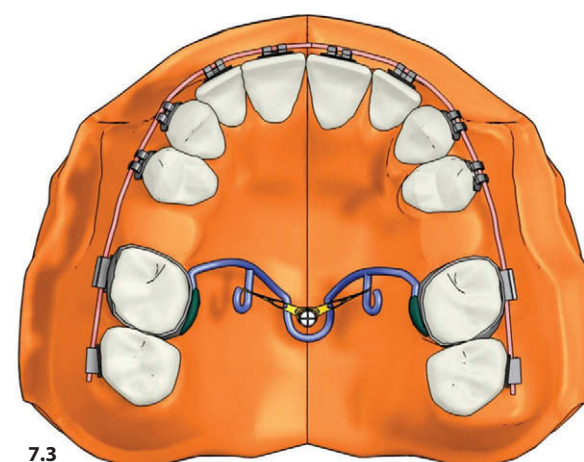
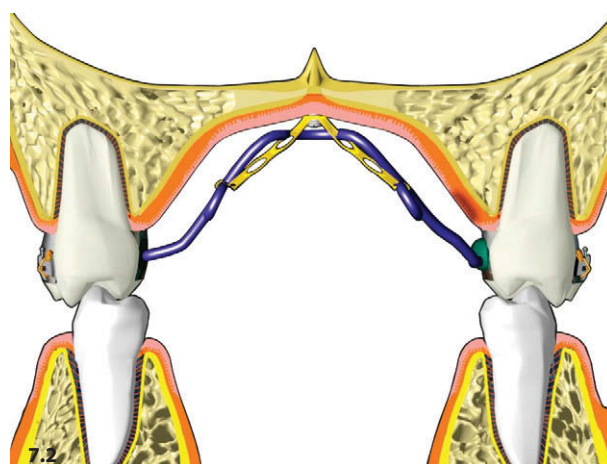
The authors advocate two main appliance designs for intrusion of posterior teeth with miniscrew anchorage:

- For upper molar intrusion: a midpalatal miniscrew implant plus transpalatal arch
- For lower molar intrusion: a buccal interdental miniscrew implant plus lingual arch

Intrusion of the entire upper dentition or intrusion of the upper posterior teeth

For intrusion of the entire upper dentition (via intrusive archwires) or intrusion of just the upper posterior teeth, the anteroposterior position of the midpalatal miniscrew implant is usually level with the first molars. The transpalatal arch should lie approximately 5.0 mm away from the palatal soft tissue to avoid soft tissue contact as intrusive movement progresses. An elastic chain is attached between hooks soldered to the arch and the miniscrew to generate the intrusive force (Figs 7.1–7.3). As the entire dentition is intruded, the anterior facial height is reduced and the chin point advances.

An alternative approach for intrusion of upper posterior teeth involves use of the inter-radicular miniscrew in either the buccal or the palatal bone, with a transpalatal arch. The palatal arch for this purpose is fabricated with a heavier gauge wire to prevent buccal/palatal tipping of the posterior teeth during intrusive movement.



Figs 7.1–7.3 Set-up for intrusion of upper teeth using midpalatal miniscrew anchorage.

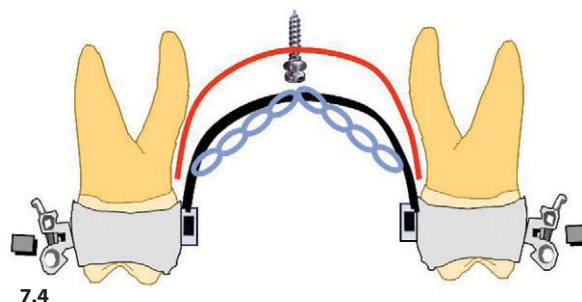
The midpalatal miniscrew design is preferred for several reasons:

- Placement of the miniscrew is easier as there are no critical anatomic structures to avoid in this area.
- Midpalatal bone quality is excellent for miniscrew retention.
- The vertical location of the miniscrew in the buccal inter-radicular bone is limited by the vestibular depth and the width of the attached gingiva in some patients.
- As the intrusive movement progresses, the distance between the miniscrew and the archwire decreases and the magnitude of intrusive force is difficult to assess. With midpalatal miniscrews, an adequate distance remains between the hook on the palatal arch and the miniscrew for intrusive force application. However, low-lying palatal arch design has disadvantage of some tongue discomfort and speech disturbance.

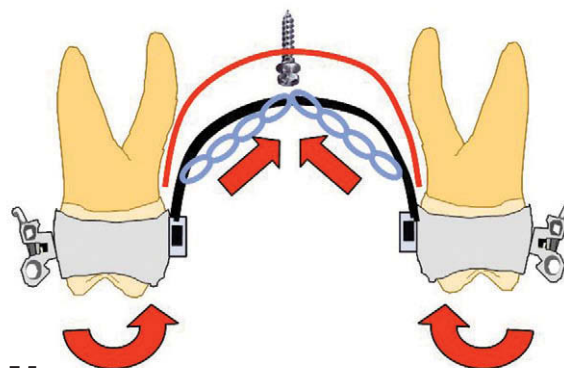
To encourage bodily intrusion of molars, the palatal/lingual arch should be made with a 1.1 mm stainless steel wire for the following reasons.

- Sheath-type attachments with a 0.9 mm steel wire are not sufficiently rigid to withstand the lingual/buccal tipping of the palatal/buccal cusps resulting from the intrusive force (Figs 7.4, 7.5).
- In the upper arch, as the intrusive force is applied over a period of time some palatal tipping of the molars can be observed even in the presence of the transpalatal arch. Use of a heavier gauge wire to construct the transpalatal arch can reduce such tipping.
- Similarly, in the lower arch, adverse movements such as buccal crown tipping can be caused by forces directed laterally to the center of resistance of the molars, resulting in posterior crossbite. This can be counteracted by constructing the lingual arch with heavy gauge stainless steel wire.

In addition, full size rectangular archwires should be placed to avoid distortion of the arch shape by the intrusive forces. Another way to avoid tipping in the upper arch is to insert additional buccal alveolar miniscrews and apply intrusive force buccally and lingually at the same time (Fig. 7.6).



7.4



7.5

Fig. 7.4, 7.5 Lingual tipping may occur with the use of a less rigid palatal arch system.

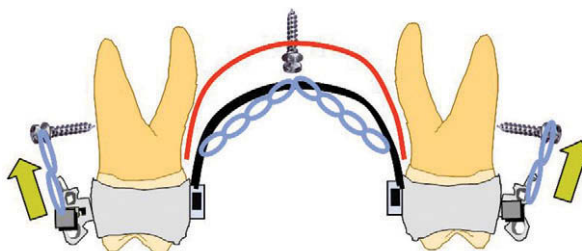


Fig. 7.6 Simultaneous buccal and lingual force application for bodily intrusion.

There are several ways of applying the intrusive force in the upper arch:

- The simplest way is to attach an elastic chain from the miniscrew to hooks made with 0.8 mm brass wire which are soldered to the transpalatal arch (Fig. 7.7).
- If the angulation between the two points of force application is increased in the vertical direction, it can be difficult to secure the elastic chain to the miniscrew. As the chain is stretched, it slips off the miniscrew. In such cases, a Kobayashi hook made with a ligature wire can be tied to the miniscrew

head, which helps to hold the elastic chain in place (Fig. 7.8).

- An elastomeric ring can also be used to secure the chain to the miniscrew head in some cases (Fig. 7.9).
- When there are no hooks on the transpalatal arch, stops made of composite can be bonded to it on either side. The elastic chain is first tied around the transpalatal arch occlusal to the composite stop. Then the other end is hooked on to the miniscrew (Fig. 7.10).
- Patients with a low palatal vault may experience discomfort as the miniscrew may irritate the tongue. Covering the miniscrew head with

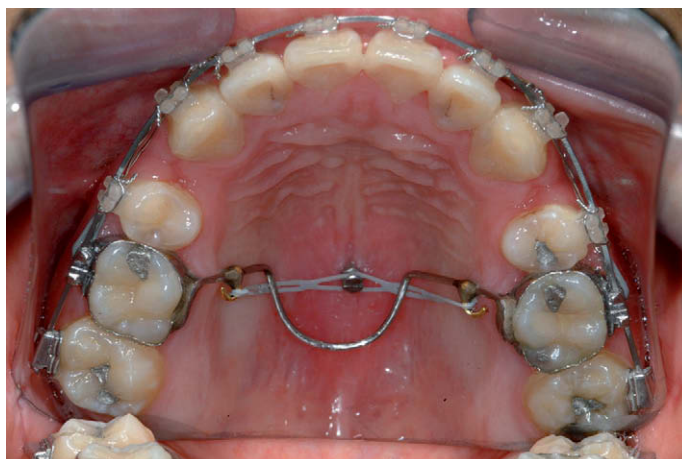


Fig. 7.7 Using an elastic chain to apply the intrusive force.

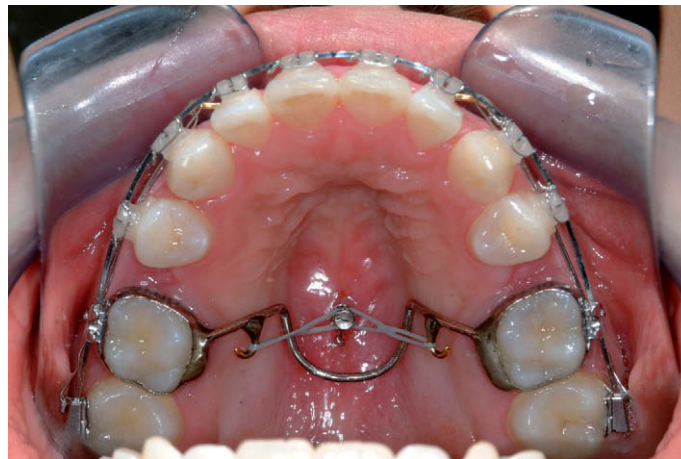


Fig. 7.8 In a patient with a deeper palate, Kobayashi hooks can help to secure the elastic chain to the miniscrew head.



Fig. 7.9 Using an elastomeric ring to secure the chain.

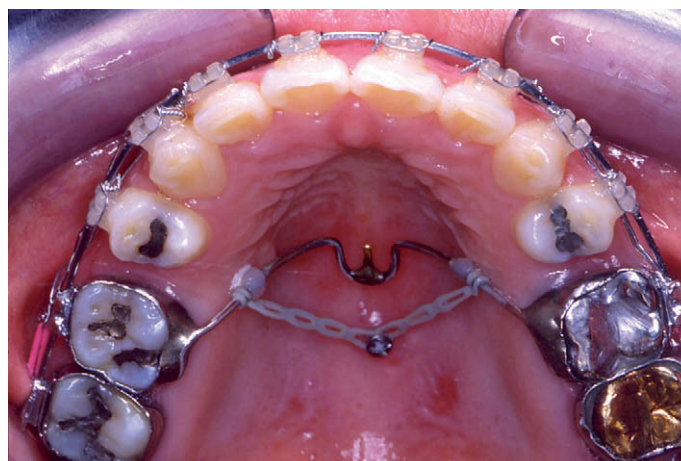


Fig. 7.10 Stops made of composite to secure the elastic chain to a transpalatal arch.

composite or a soft periodontal dressing can help to reduce this discomfort (Fig. 7.11).

- Sometimes the vertically directed chain can 'float' in the mouth and interfere with tongue movement. Twisting the chain around the arms of the transpalatal arch can prevent this (Fig. 7.12).
- Nickel-titanium coil springs may also be used to apply intrusive orthodontic force. However, the elastic chain is superior with regard to patient comfort (Fig. 7.13).



Fig. 7.11 A miniscrew head covered with composite to prevent tongue irritation.

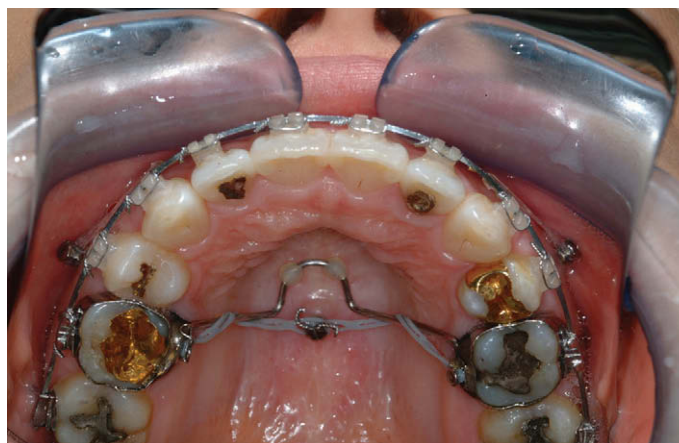


Fig. 7.12 Chain twisted around the palatal arch to prevent it from hanging freely in the mouth.

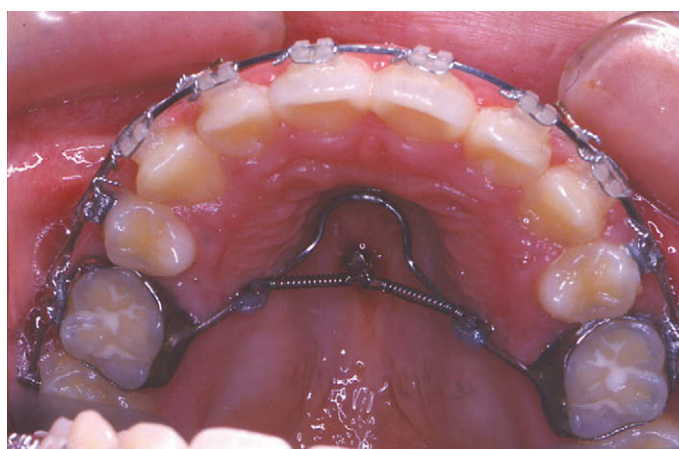


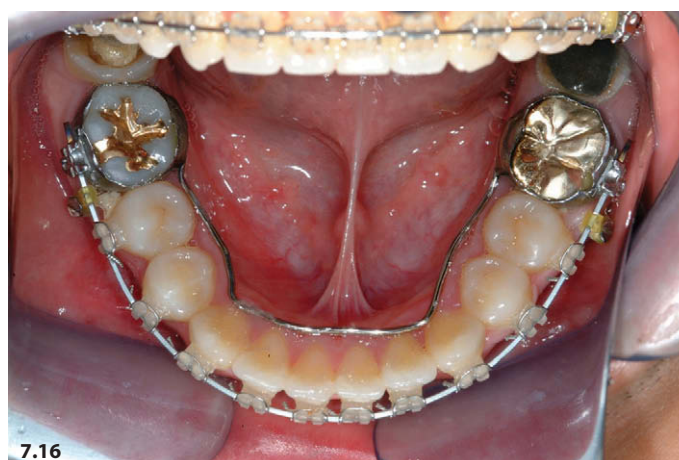
Fig. 7.13 Intrusive force being applied through nickel titanium springs.

Intrusion of the entire lower dentition or the lower posterior teeth

In the lower arch, miniscrews are inserted in the inter-radicular bone between the first and second molars for intrusion of the entire lower dentition or the lower posterior teeth. A rectangular archwire is engaged in the lower fixed appliance and a lingual arch is placed. An elastic chain is tied between the archwire and buccal alveolar miniscrews to apply intrusive force on the lower teeth (Figs 7.14–7.16).

Intrusion of the upper anterior teeth

For intrusion of upper anterior teeth, the miniscrew is placed between the roots of the incisor teeth. A single miniscrew can be placed between the central incisor roots. In this design, since a single force is applied at the center of the arch, a reverse smile line can be created as the incisors are intruded. To reduce the likelihood of this problem, two miniscrews can be placed instead, one on either side of the arch, between the lateral incisor and canine roots. The transverse distance between the roots of the incisors increases toward the root apices. Therefore more apical placement of a miniscrew will minimize the possibility of miniscrew–root contact. When determining the vertical location of the miniscrew, it must be kept in mind that the vertical distance between the archwire and the miniscrew will decrease as the anterior teeth are intruded. If the miniscrew will be placed in the unattached gingiva, the closed-pull method (see Chapter 5) should be used.



Figs 7.14–7.16 Set-up for intrusion of lower teeth using buccal alveolar miniscrew anchorage.

Intrusion of the lower anterior teeth

For intrusion of lower anterior teeth, the miniscrew is placed between the roots of the incisor teeth. The inter-radicular space is narrow between the lower incisors, therefore it is better to use a smaller diameter (<1.6 mm) miniscrew and place it more apically to avoid root–miniscrew contact. If the miniscrew will be placed in the unattached gingiva, the closed-pull method (see Chapter 5) should be used.

OPTIMUM FORCE LEVELS

A force gauge is used for accurate measurement of the intrusive force. The authors advocate a force of 250–300 g per side for intrusion of entire dentition. As the first molars are joined by a heavy palatal/lingual arch and the entire dentition is held together with a rectangular archwire, the intrusive force is distributed to the entire dentition. Therefore it is reasonable to apply a heavier intrusive force than is usually recommended with traditional orthodontic mechanics (Fig. 7.17). Lighter force of 60–120 g (10–20 g per tooth) is applied for intrusion of anterior teeth.



Fig. 7.17 Measuring the intrusive force.

OCCLUSAL AND FACIAL CONSEQUENCES OF ORTHODONTIC INTRUSION

The vertical position of the maxilla has a strong influence on both the anteroposterior and vertical positions of the mandible and the lower incisors. As the maxilla moves downward, the mandible rotates backward and vice versa. For example, in a patient with excessive vertical growth of the maxilla there is downward and backward rotation of the mandible. Conversely, when the maxilla is intruded, the mandible moves upward and forward. Hence a Class II dental relationship improves with maxillary molar intrusion but a Class III dental relationship becomes worse.

Therefore, an important consideration for molar intrusion, other than the periodontal health of the teeth, is the incisor relationship. There should be sufficient amount of overjet prior to molar intrusion to accommodate the upward and forward movement of the lower incisors along with the mandible (Fig. 7.18). A patient who initially had a normal incisor relationship may show anterior edge-to-edge bite or

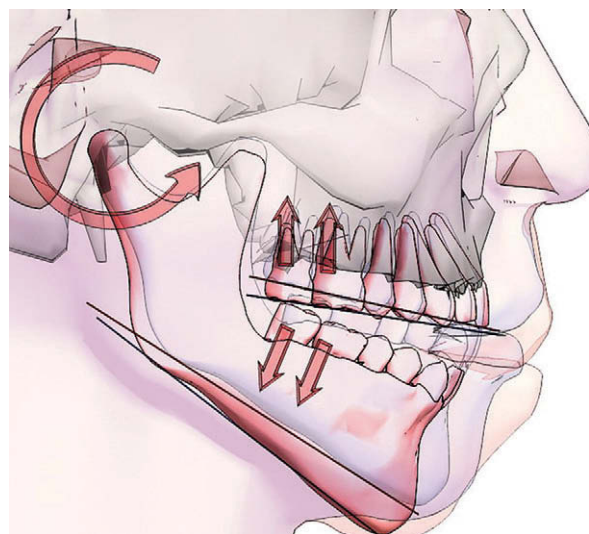


Fig. 7.18 Maxillary intrusion influences the maxillo-mandibular jaw and dental relationships.

even crossbite following maxillary intrusion. Traumatic occlusion of incisors may also develop. Thus the greater the amount of intrusion required, the greater should be the amount of pretreatment overjet – or the overjet must be actively increased during treatment. An accentuated curve of Spee placed in the upper archwire can also help prevent traumatic occlusion of incisors as the mandible autorotates upward and forward in a counterclockwise direction. The added curve in the archwire generates an intrusive force on the anterior teeth while the posterior teeth are intruded by the traction force from the miniscrew. In this way the entire dentition is intruded, the anterior facial height is reduced and the chin point advances. In a patient with severe vertical maxillary excess, the results of this treatment are comparable with those of surgical maxillary impaction. The term ‘slow impaction’ may be used for this intrusion of the maxillary dentition by orthodontic means.⁶

MINISCREW IMPLANT ANCHORAGE FOR INTRUSION OF THE ENTIRE DENTITION

Control of extrusion of the posterior teeth is important during treatment of patients with vertical maxillary excess. However, in non-growing patients, it is uncertain whether orthodontic treatment alone can intrude the posterior teeth enough to achieve optimal facial balance. Studies of active bite-block therapy with⁸ or without repelling magnets^{9,10} have reported post-treatment mandibular autorotation and a concomitant reduction of anterior face height. However, such treatment is heavily dependent on patient compliance and the appliances are bulky. Other studies have focused on the intrusion of a single posterior tooth^{11–13} or combined surgical procedures to solve the problem.^{14,15} Although intrusion of anterior teeth is feasible using posterior teeth as anchorage, intrusion of posterior teeth is difficult because of inadequate dental anchorage.

Miniscrew implants provide adequate anchorage to intrusion the entire maxillary dentition, mandibular dentition or both.

CASE 7.1

Intrusion of the maxillary dentition in a patient with vertical maxillary excess

Presenting complaint and clinical examination

A 26-year-old Korean woman presented with skeletal class II malocclusion. Three second premolars had been extracted prior to her initial orthodontic examination.

She also had severe lip protrusion and mentalis strain on closing (Figs 7.19–7.28).



Fig. 7.19



Fig. 7.20



Fig. 7.21



Fig. 7.22



Fig. 7.23



Fig. 7.24



Fig. 7.25



Fig. 7.26



Fig. 7.27



Fig. 7.28

Radiographic evaluation

Cephalometric analysis revealed a retrognathic mandible, excess anterior and posterior dentoalveolar height and an increased maxillo-mandibular planes

angle – features commonly associated with vertical maxillary excess (Figs 7.29, 7.30; Table 7.1).¹⁶



Fig. 7.29



Fig. 7.30

Treatment objectives and plan

The aim of the treatment was to achieve maximum retraction of the anterior teeth without increasing the vertical dimension.

Treatment

The lower right second premolar and lower left third molar were extracted. Upper and lower teeth were banded/bonded with .022/.028 preadjusted fixed appliances. Two Martin® miniscrews (diameter 1.6 mm, length 6.0 mm) were placed between the upper first and second molars under local infiltrative anesthesia. Leveling and aligning of the upper and lower dentitions was started (Figs 7.31–7.35). When the treatment plan includes miniscrew placement in the inter-radicular space, it is usually recommended that the miniscrews are placed after leveling and aligning of the teeth is complete. This aids in determining the best possible

Table 7.1 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS	
Anteroposterior	
SNA (deg)	78.5
SNB (deg)	73.0
ANB (deg)	5.5
Vertical	
GoMe/SN (deg)	44.5
FMPA (deg)	35.0
PP/MP (deg)	39.8
Lower gonial (deg)	82.0
ANS–Me (mm)	82.2
DENTAL ANALYSIS	
Overjet (mm)	3.0
Overbite (mm)	1.5
UI/SN (deg)	105.0
L1/GoMe (deg)	107.4
SN/OP (deg)	19.5
Is–Is' (mm)	41.8
Mo–Ms (mm)	32.5
li–li' (mm)	51.4
Mo–Mi (mm)	39.5
LIP ANALYSIS	
U Lip–E (mm)	1.8
L Lip–E (mm)	7.0
NLA (deg)	82.0

See page ix for Korean norms.
Is–Is': Upper anterior dentoalveolar height (UI–NF)
li–li': Lower anterior dentoalveolar height (LI–GoMe)
Mo–Ms: Upper posterior dentoalveolar height (U6–NF)
Mo–Mi: Lower posterior dentoalveolar height (L6–GoMe)

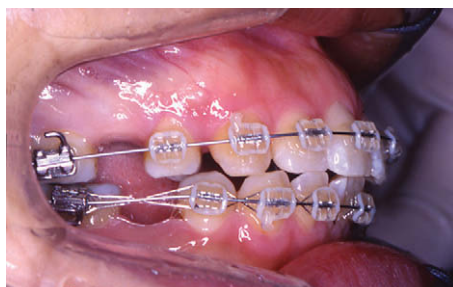


Fig. 7.31



Fig. 7.32

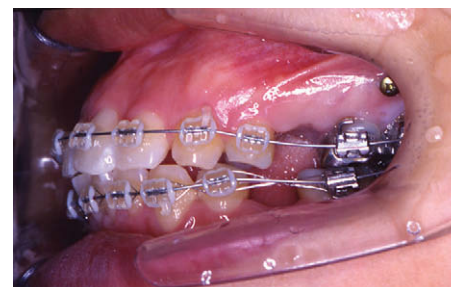


Fig. 7.33

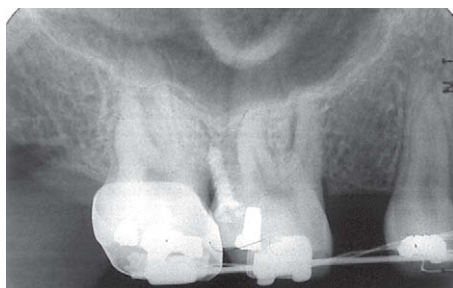


Fig. 7.34

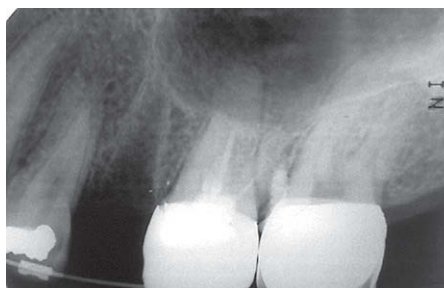


Fig. 7.35

location for the miniscrew and avoids root damage during and after placement. Therefore, depending on the initial alignment of the teeth, timing of miniscrew placement in the upper and lower arches may vary and some anchorage loss is inevitable during the initial aligning and leveling stage of treatment. For this patient, the miniscrews were placed before the teeth were aligned. When doing this, there is a risk of miniscrew–root contact as the teeth are aligned. However, in this patient the teeth were initially well aligned and the risk of miniscrew–root contact was not a concern in the leveling and aligning phase. When placing a miniscrew before alignment is complete, apical positioning and vertical orientation is advocated. This was one of our first cases involving use of miniscrew implant anchorage, and along with our other early cases informed our learning regarding the appropriate time for miniscrew placement, optimal force magnitude, appliance design, etc.

After 7 months of treatment, .019/.025 stainless steel working archwires were engaged in both arches. The upper right miniscrew showed mobility and was removed. Another miniscrew implant was placed in the posterior midpalatal suture area, anteroposteriorly level with the first molars, under local infiltrative anesthesia. The upper left miniscrew was removed as it was no longer needed. As anchorage was needed for intrusion of upper posterior teeth in this patient, the midpalatal suture area was selected for placing a new miniscrew. The midpalatal suture area has excellent bone quality for miniscrew retention in adults and only single screw is needed. A 256:1 contra-angle handpiece was used for insertion of the miniscrew. A transpalatal arch was fitted on the first molars and an elastic chain was connected from the arch to the midpalatal screw. The transpalatal arch was designed such that the central loop was located approximately 5 mm from the palatal tissue and 10 mm anterior to the midpalatal miniscrew

to provide anchorage for the retraction of anterior teeth and to apply intrusive forces on the upper posterior teeth. With a low transpalatal arch as this, there is usually some tongue irritation and speech disturbance. Composite stops were bonded on the transpalatal arch and elastic chains used to apply intrusive force on the maxillary dentition (Fig. 7.36). Two more OsteoMed® miniscrew implants (diameter 1.6 mm, length 8.0 mm) were placed in the interdental alveolar bone between the lower first and second molars under local infiltrative anesthesia (Figs 7.37–7.41).

Two months later, the lower right miniscrew became mobile and was removed; another miniscrew (diameter

1.4 mm, length 8.0 mm) was placed in the interdental bone between the lower first premolar and first molar. This time a pilot hole was drilled prior to placement of the miniscrew to prevent its breakage. In the past, when this patient was being treated, only bone screws were available. Those bone screws with diameters less than 1.6 mm did not have self-drilling qualities. When a miniscrew becomes loose, an alternative site is selected for the replacement miniscrew. If the new one is to be placed in the same location, it is necessary to wait for 10–12 weeks for the bone to fill the hole created and mineralize. This is associated with a prolonged treatment period.

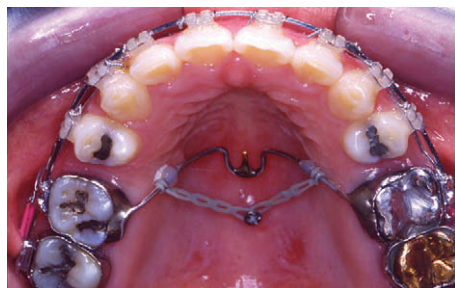


Fig. 7.36

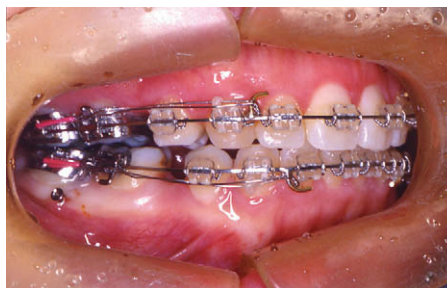


Fig. 7.37



Fig. 7.38



Fig. 7.39



Fig. 7.40

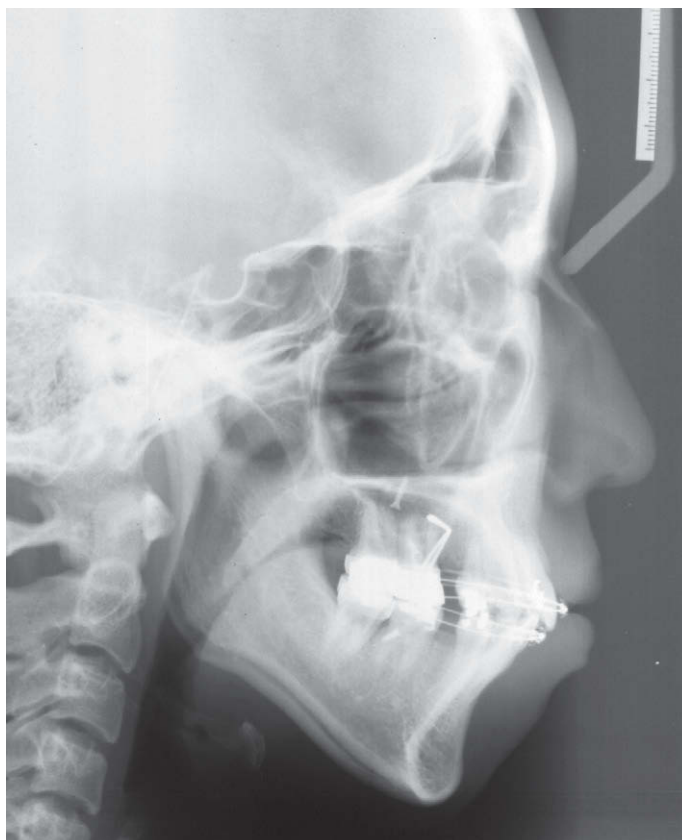


Fig. 7.41

The lower anterior teeth were retracted by applying force between the miniscrews and the presoldered hooks on the archwire. In the upper arch, distal force was added at the miniscrew (Figs 7.42–7.44).

Twelve months after the midpalatal miniscrew was placed, hooks were soldered to the transpalatal arch so that the elastic chain could be applied more easily (Fig. 7.45; see also Figs 7.1–7.3 and accompanying text). The total treatment time was 27 months and no more miniscrews were required.

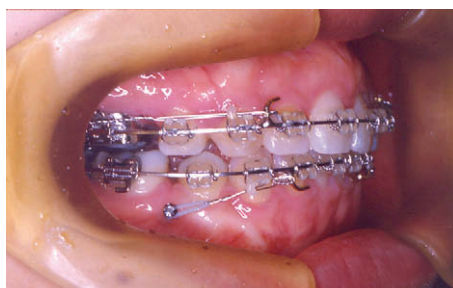


Fig. 7.42

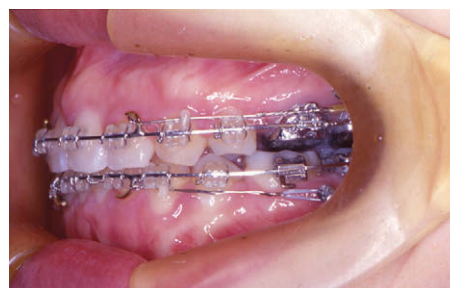


Fig. 7.43



Fig. 7.44

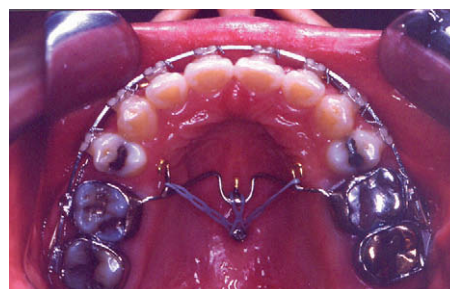


Fig. 7.45

Post-treatment evaluation

Excellent improvement was noted in the nose–lip–chin relationship because of the reduction in the lower anterior facial height. The chin showed a more esthetic appearance (Figs 7.46–7.55)

A small amount of apical root resorption was seen in the post-treatment panoramic radiograph (Fig. 7.56). Several factors may have contributed to this finding in this patient. There was a considerable amount of



Fig. 7.46



Fig. 7.47



Fig. 7.48



Fig. 7.49

tooth movement, to the extent that there was minimal overlap of the pretreatment and post-treatment incisor position. Considerable remodeling in the subspinale and lower alveolar regions occurred as a result of the

large amount of incisor retraction and intrusion. Teeth that are moved through greater distances and intrusive movements are more prone to root resorption. Also, in this patient, as the upper posterior teeth were intruded,



Fig. 7.50



Fig. 7.51



Fig. 7.52



Fig. 7.53

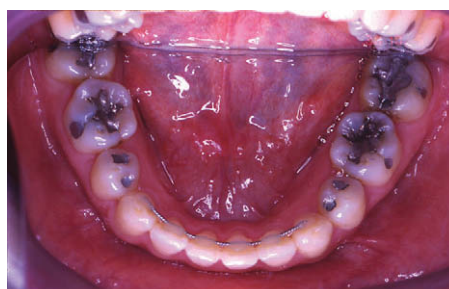


Fig. 7.54



Fig. 7.55



Fig. 7.56

the upper incisors were subjected to trauma from contact with the lower anterior teeth during closure. To eliminate the traumatic bite, an accentuated curve of Spee was incorporated in the upper archwire and a reverse curve in the lower archwire for more than half of the treatment period. Lastly, heavy intrusive forces were used in this patient with the aim of intruding of the entire maxillary dentition. However, when optimum force is used, root resorption is not of concern. Usually, the amount of root resorption expected to occur with the use of miniscrew implant anchorage is similar to that expected with conventional orthodontic treatment, regardless of the amount and direction of tooth movement.

Cephalometric measurements confirmed the decrease in anterior and posterior dentoalveolar heights and reduction of vertical skeletal measurements, mainly due to reduction in upper posterior dentoalveolar height (Figs 7.57–7.59; Table 7.2). Initially, reduction and advancement genioplasty after orthodontic treatment had been proposed because of the severity of lip protrusion and retrognathism. However, at this stage it was no longer considered necessary.



Fig. 7.57

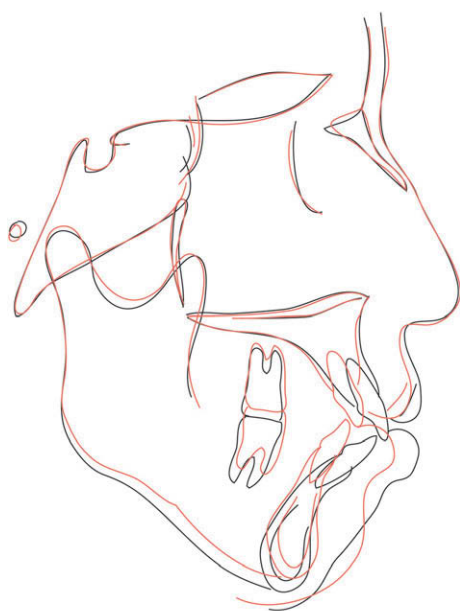


Fig. 7.58

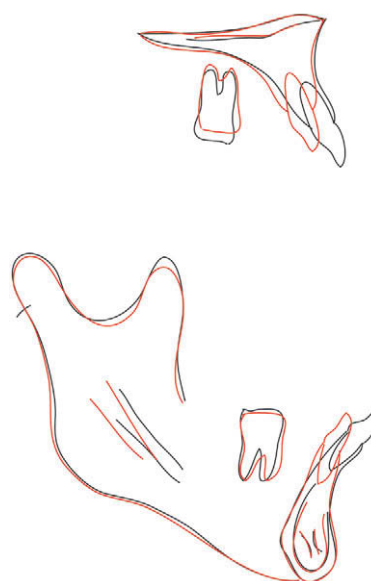


Fig. 7.59

Table 7.2 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	78.5	78.0
SNB (deg)	73.0	73.3
ANB (deg)	5.5	4.7
Vertical		
GoMe/SN (deg)	44.5	43.0
FMPA (deg)	35.0	34.0
PP/MP (deg)	39.8	37.1
Lower gonial (deg)	82.0	80.0
ANS–Me (mm)	82.2	79.0
DENTAL ANALYSIS		
Overjet (mm)	3.0	3.0
Overbite (mm)	1.5	2.0
UI/SN (deg)	105.0	98.0
L1/GoMe (deg)	107.4	88.0
SN/OP (deg)	19.5	19.0
Is–Is' (mm)	41.8	36.2
Mo–Ms (mm)	32.5	29.5
Ii–Ii' (mm)	51.4	46.5
Mo–Mi (mm)	39.5	38.5
LIP ANALYSIS		
U Lip–E (mm)	1.8	–2.7
L Lip–E (mm)	7.0	–0.3
NLA (deg)	82.0	88.0
See page ix for Korean norms. See Table 7.1 and page x for abbreviations.		

Clinical tip

When molar intrusion is not a part of the initial treatment plan, but is deemed necessary in the middle of the treatment, a transpalatal arch with hooks may be bonded to the first molars (Fig. 7.60).

Discussion

In patients with vertical maxillary excess, extractions provide space to move the anterior teeth only in the anteroposterior plane. The conventional force systems used to reposition the dental segments tend to extrude the posterior teeth and are likely to make both the occlusion and the facial appearance worse. Thus, intrusion of the posterior teeth was a key factor in the successful treatment outcome for this patient. During the treatment the upper first molars were intruded by 3.0 mm. To allow counterclockwise rotation of the mandible, the maxillary incisors were intruded as well by incorporating curve of Spee in the upper archwire. With autorotation of the mandible there was a 3.2 mm decrease in the anterior lower facial height. The lower molars showed minimal change in their anteroposterior position and were intruded by 1.0 mm. Although the treatment was directed at controlling the vertical dimension, it also produced a favorable response in the anteroposterior relationships as the chin moved anteriorly and superiorly (see Figs 7.57–7.59). The amount of molar intrusion and associated mandibular autorotation seen here is similar to that seen after LeFort I maxillary osteotomies.¹⁷

Case 7.1 was previously published in the Journal of Clinical Orthodontics (Paik C H, Woo Y J, Boyd R L 2003 Treatment of an adult patient with vertical maxillary excess using miniscrew fixation. Journal of Clinical Orthodontics 37:423–428)



Fig. 7.60

MINISCREW IMPLANT ANCHORAGE FOR INTRUSION OF POSTERIOR TEETH

Miniscrew implant anchorage for intrusion of the posterior teeth can be used in both arches and

unilaterally or bilaterally. The following case illustrates some of these possibilities.

CASE 7.2

Unilateral intrusion and retraction of posterior teeth in a patient with skeletal Class II malocclusion and deep overbite

Presenting complaint and clinical examination

A 31-year old Korean woman presented with the chief complaint of anterior crowding and protrusive lips. She had a convex profile with a recessive chin. There was mentalis strain on lip closure. The philtrum and the upper central incisors were skewed to the left. Occlusal canting was also present with greater gingival exposure of right buccal segment (Figs 7.61–7.64).

On intraoral examination she had upper and lower anterior crowding. The overbite was 5.0 mm and the overjet was 6.0 mm. There was 2.0 mm vertical step



Fig. 7.61



Fig. 7.62



Fig. 7.63



Fig. 7.64

between the right upper lateral and central incisor edges. The canine and molar relationships were Class II on both sides. The right buccal segment was positioned more forward, causing the upper dental midline to deviate to the left. The upper arch form was distorted (Figs 7.65–7.70).

Radiographic evaluation

The panoramic radiograph showed the mandibular left third molar was horizontally impacted. Slight resorption of the left condyle head was also seen (Fig. 7.71).



Fig. 7.65



Fig. 7.66



Fig. 7.67



Fig. 7.68



Fig. 7.69



Fig. 7.70



Fig. 7.71

Cephalometric analysis revealed a skeletal Class II relationship with a retrognathic mandible. The palatal plane to mandibular plane, lower gonial and the GoMe/SN angles were increased indicating an increased maxillo-mandibular planes angle. Axial inclination of the maxillary and mandibular incisors was normal. The lips were protrusive to the esthetic (E) line owing to the retrusive position of the chin (Fig. 7.72; Table 7.3).



Fig. 7.72

The PA cephalogram showed deviation of the chin point to the left by 3.0 mm from the skeletal midline owing to vertical maxillary asymmetry. The maxillary right first molar was positioned more inferiorly by 2.5 mm compared with the left. The maxillary dental midline was deviated to the left but the mandibular midline was coincident with the facial midline (Fig. 7.73).

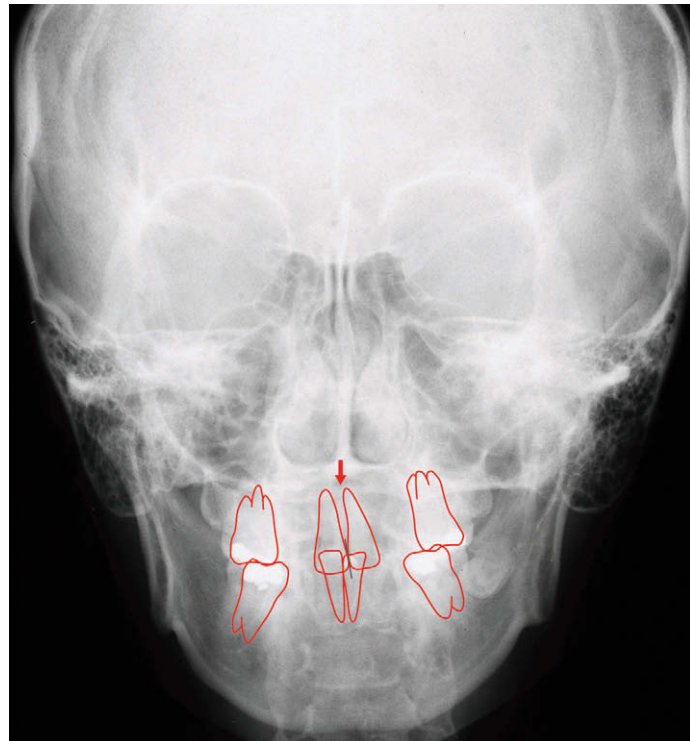


Fig. 7.73

Table 7.3 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	82.0
SNB (deg)	74.5
ANB (deg)	7.5

Vertical

GoMe/SN (deg)	42.5
FMPA (deg)	36.5
PP/MP (deg)	31.0
Lower gonial (deg)	81.0
ANS–Me (mm)	67.5

DENTAL ANALYSIS

Overjet (mm)	6.0
Overbite (mm)	5.0
UI/SN (deg)	102.0
L1/GoMe (deg)	97.0
SN/OP (deg)	18.0
Is–Is' (mm)	31.0
Mo–Ms (mm)	25.0
Ii–Ii' (mm)	49.0
Mo–Mi (mm)	36.0

LIP ANALYSIS

U Lip–E (mm)	2.0
L Lip–E (mm)	7.0
NLA (deg)	99.0

See page ix for Korean norms.
See Table 7.1 and page x for abbreviations.

Treatment objectives and plan

The treatment objectives were to achieve ideal overjet and overbite, reduce the lip protrusion, establish bilateral Class I canine and Class II molar relationships, and correction of the upper dental midline discrepancy.

The treatment plan was to extract the maxillary right first and left second premolars to relieve incisor crowding and facilitate upper midline correction. Two miniscrew implants would be placed for different purposes. The first miniscrew implant would be placed in the midpalatal region to provide anchorage for intrusion of the right buccal segment and therefore correction of the vertical molar discrepancy. The second miniscrew would be placed in the right maxillary tuberosity area to provide anchorage for the retraction of the right buccal segment and correction of the upper dental midline.

Treatment

Following the extraction of the maxillary right first and left second premolars, a transpalatal arch was fitted on the upper molars. The upper and lower arches were bonded with a .022/.028 preadjusted fixed appliance and leveling and alignment started. The archwires were progressively increased up to .019/.025 stainless steel wire. At 6 months, retraction of the anterior teeth was started. Space closure was begun with light and continuous forces delivered by active tiebacks from the anterior hooks on the archwire to the second molar attachment hooks. The patient complained of discomfort in the left third molar area, and the horizontally impacted mandibular left third molar was extracted.

Miniscrew placement and further treatment

At 12 months into treatment, three-quarters of the right maxillary first premolar extraction space was closed and the upper dental midline nearly aligned with the lower dental midline. An OsteoMed® miniscrew (diameter 1.6 mm, length 6.0 mm) was placed in the midpalatal region between the maxillary first and second molars anteroposteriorly, under infiltrative local anesthesia. The miniscrew was placed few millimeters to the right of the suture. A hook was soldered on the right arm of the transpalatal arch. A force of 150 g was applied a week after miniscrew implant placement. An elastic module was connected from the miniscrew to the hook on the transpalatal arch to generate intrusive and distally directed force to the right maxillary posterior teeth to correct the vertical discrepancy. A segmental archwire was inserted from premolar to premolar and the transpalatal arch was removed to solder a hook. Soon after a continuous archwire was inserted in the upper arch. To avoid premature contact of incisors as the upper molars were intruded, an accentuated curve of Spee was added to the upper archwire and a reverse curve of Spee was incorporated in the mandibular arch (Figs 7.74–7.78).

Five months later when the vertical molar discrepancy was corrected, the midpalatal miniscrew implant was removed. Another OSAS® miniscrew (diameter 1.6 mm, length 8.0 mm) was placed distal to the right maxillary second molar in the tuberosity area. The longer length miniscrew was selected because of the greater soft tissue thickness in this region (see Chapter 5 for detailed explanation). An elastic chain was attached between the miniscrew and the hook on the transpalatal arch to retract the right buccal segment (Figs 7.79–7.84).

The active treatment time was 26 months. Lingual fixed retainers were bonded to the upper and lower anterior teeth immediately after bracket removal. The patient was also given an upper wraparound retainer and a lower Hawley retainer.



Fig. 7.74



Fig. 7.75



Fig. 7.76



Fig. 7.77



Fig. 7.78

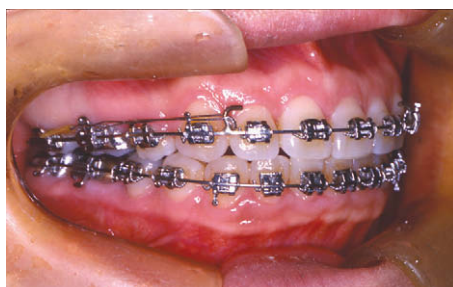


Fig. 7.79



Fig. 7.80



Fig. 7.81



Fig. 7.82



Fig. 7.83



Fig. 7.84

Post-treatment evaluation

There was an improvement in the lip profile as the lip protrusion was reduced and mentalis strain had disappeared. The maxillary central incisors had been uprighted and the occlusal plane had been leveled (Figs 7.85–7.88).



Fig. 7.85



Fig. 7.86



Fig. 7.87



Fig. 7.88

Both arches were well aligned and coordinated. The upper and lower dental midlines were aligned and optimal overbite and overjet were established. Bilateral Class I canine and Class II molar relationships were attained (Figs 7.89–7.94).

The post-treatment panoramic radiograph showed good overall root parallelism except for mandibular central incisors. Only slight root resorption was noted on the upper incisors despite the considerable amount of movement of these teeth (Figs 7.95–7.97).



Fig. 7.89



Fig. 7.90



Fig. 7.91



Fig. 7.92



Fig. 7.93



Fig. 7.94



Fig. 7.95



Fig. 7.96

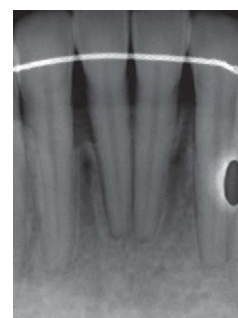


Fig. 7.97

The post-treatment lateral cephalogram and superimposed tracings show reduction in the anterior facial height and mandibular plane angle due to the autorotation of the mandible following intrusion of the maxillary molars. The maxillary incisors moved posteriorly and superiorly. A considerable amount of remodeling of the subspinale area was seen as a result of large amount of maxillary incisor retraction. The maxillary posterior teeth moved superiorly and anteriorly. The maxillary incisors had been intruded by the incorporation of the accentuated curve of Spee in the upper archwire; extrusion of the maxillary molars was avoided by applying intrusive force from the midpalatal miniscrew implant. Intrusion of mandibular incisors resulted from the reverse curve added to the mandibular archwire (Figs 7.98–7.100; Table 7.4).



Fig. 7.98

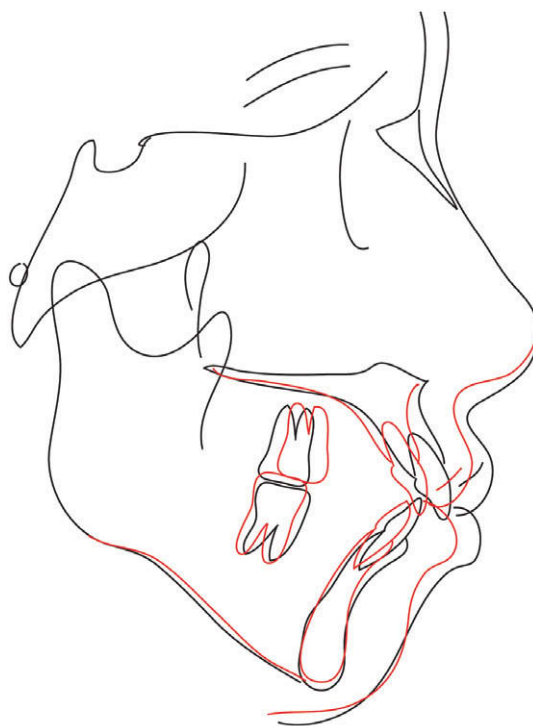


Fig. 7.99

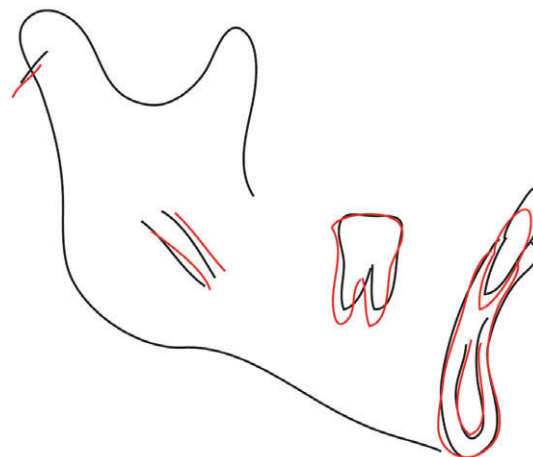
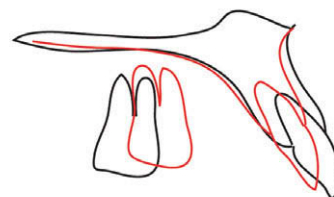


Fig. 7.100

Table 7.4 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	82.0	79.5
SNB (deg)	74.5	74.5
ANB (deg)	7.5	5.0
Vertical		
GoMe/SN (deg)	42.5	40.0
FMPA (deg)	36.5	33.0
PP/MP (deg)	31.0	27.0
Lower gonial (deg)	81.0	79.0
ANS–Me (mm)	67.5	67.0
DENTAL ANALYSIS		
Overjet (mm)	6.0	3.0
Overbite (mm)	5.0	2.5
UI/SN (deg)	102.0	101.0
L1/GoMe (deg)	97.0	95.5
SN/OP (deg)	18.0	19.0
Is–Is' (mm)	31.0	29.5
Mo–Ms (mm)	25.0	25.0
Ii–Ii' (mm)	49.0	44.0
Mo–Mi (mm)	36.0	35.2
LIP ANALYSIS		
U Lip–E (mm)	2.0	–1.5
L Lip–E (mm)	7.0	1.7
NLA (deg)	99.0	89.0

See page ix for Korean norms.
See Table 7.1 and page x for abbreviations.

The post-treatment PA cephalogram showed correction of vertical molar discrepancy and mandibular asymmetry (Fig. 7.101).

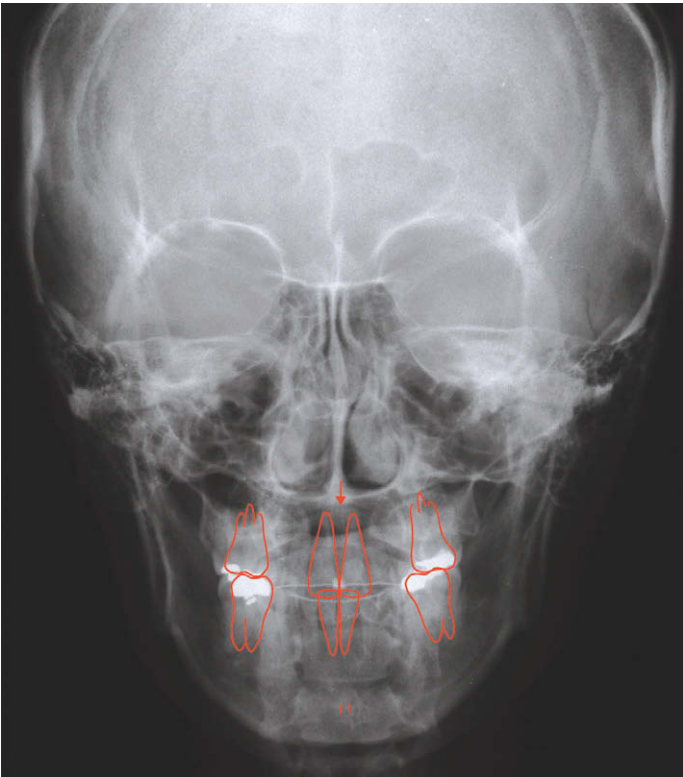


Fig. 7.101

At 3 years and 2 months' follow-up there were no post-treatment changes of note (Figs 7.102–7.114).



Fig. 7.102



Fig. 7.103



Fig. 7.104



Fig. 7.105



Fig. 7.106



Fig. 7.107



Fig. 7.108



Fig. 7.109



Fig. 7.110



Fig. 7.111

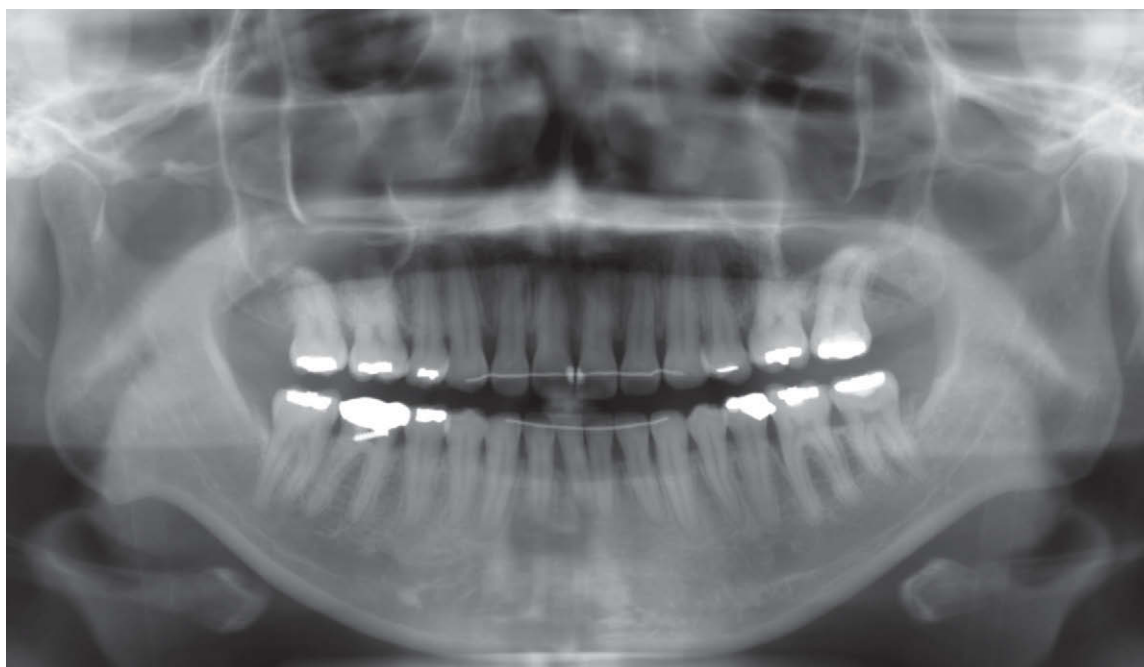


Fig. 7.112

Case 7.2 was previously published in the American Journal of Orthodontics and Dentofacial Orthopedics. (Paik C H, Ahn S J, Nahm D S 2007 Correction of Class II deep overbite and dental and skeletal asymmetry with 2 types of palatal miniscrews. American Journal of Orthodontics and Dentofacial Orthopedics 131:S106–116)



Fig. 7.113



Fig. 7.114

CASE 7.3

Intrusion of upper and lower posterior teeth in a patient with Class I anterior open bite

Presenting complaint and clinical examination

A 30-year-old Korean woman presented with a chief complaint of poor facial esthetics due to a severe anterior open bite. She had a tongue thrust, which had contributed to the formation and maintenance of her anterior open bite. She was also a mouth breather and

had a mild lisp. Her profile was moderately convex with full, incompetent lips. From the frontal view, the face was symmetric with no tooth display in lip repose. Less than 1 mm of the teeth were visible on smiling (Figs 7.115–7.118).



Fig. 7.115



Fig. 7.116



Fig. 7.117



Fig. 7.118

Intraoral examination revealed Class I canine and molar relationships on both sides with 7.2 mm open bite and 3.6 mm overjet. There was moderate lower anterior crowding and 1–2 mm gingival recession on the labial surfaces. The upper dental midline was centered in the face but the lower dental midline was 1.3 mm to the left. The upper arch had a broad U shape and the lower arch was square shaped. There was a reverse curve of Spee in the lower arch and an exaggerated curve of Spee in the upper arch (Figs 7.119–7.124).

Radiographic evaluation

The panoramic radiograph revealed a full complement of teeth, except for the lower left third molar. A slight amount of horizontal alveolar bone loss was evident (Fig. 7.125), although oral hygiene was excellent with no signs of active inflammation.



Fig. 7.119



Fig. 7.120



Fig. 7.121



Fig. 7.122



Fig. 7.123



Fig. 7.124

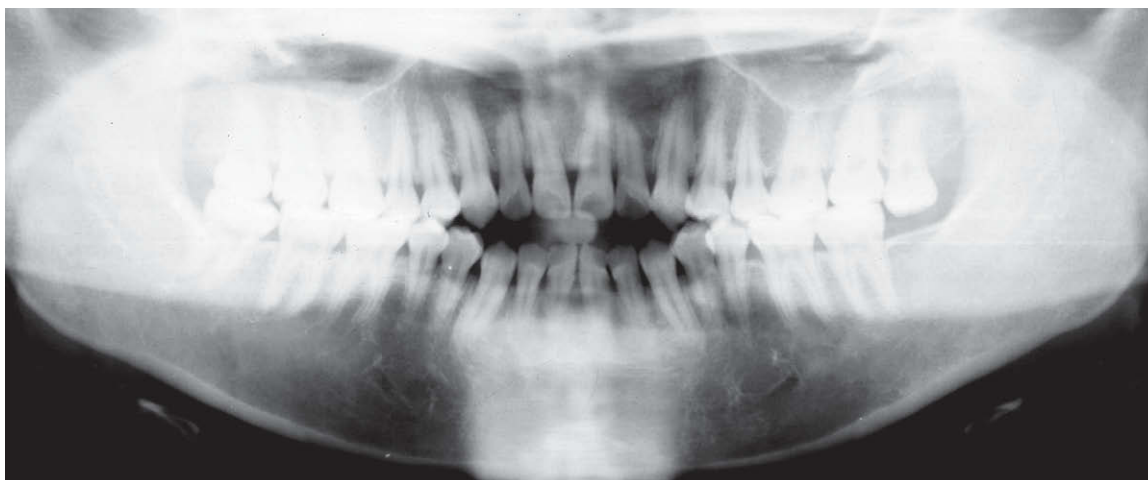


Fig. 7.125

Cephalometric analysis revealed a skeletal Class I relationship with anterior open bite. Both the upper and the lower incisors were proclined. The lips were protrusive relative to the E line. The upper and lower posterior dentoalveolar heights (Mo–Ms, Mo–Mi [see Table 7.5 footnote for explanation]) were excessive. The palatal plane to mandibular plane, lower gonial and GoMe/SN angles were all increased (Fig. 7.126; Table 7.5).

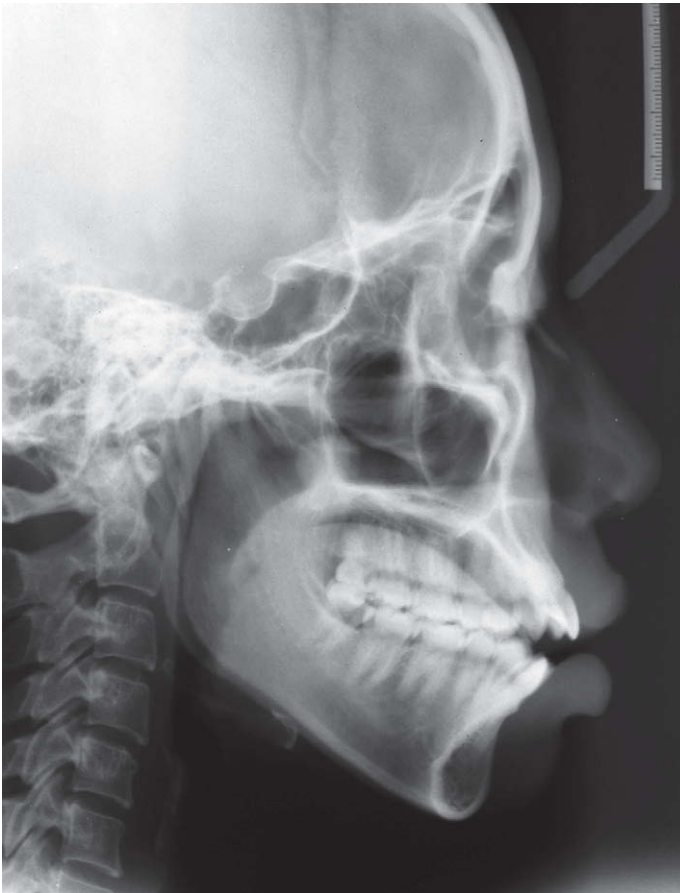


Fig. 7.126

Table 7.5 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	92.0
SNB (deg)	84.0
ANB (deg)	8.0

Vertical

GoMe/SN (deg)	36.0
FMPA (deg)	29.2
PP/MP (deg)	28.0
Lower gonial (deg)	79.4
ANS–Me (mm)	81.3

DENTAL ANALYSIS

Overjet (mm)	3.6
Overbite (mm)	–7.2
UI/SN (deg)	111.5
L1/GoMe (deg)	103.8
SN/OP (deg)	20.5
Is–Is' (mm)	33.8
Mo–Ms (mm)	32.0
li–li' (mm)	46.7
Mo–Mi (mm)	42.0

LIP ANALYSIS

U Lip–E (mm)	3.4
L Lip–E (mm)	7.1
NLA (deg)	86.0

See page ix for Korean norms.
See Table 7.1 and page x for abbreviations.

Treatment objectives and plan

Treatment objectives for the maxillary teeth were molar intrusion and esthetic repositioning of the anterior teeth to increase incisor display at rest and during smile. Goals for the mandibular dentition were intrusion of molar teeth to reduce the excessive lower vertical height and allow autorotation of the mandible. Other associated goals were reduction of lip protrusion and elimination of mentalis strain on lip closure.

The treatment plan was to extract the four first premolars to reduce the dentoalveolar protrusion. The open bite would be closed with posterior intrusive mechanics with anchorage via miniscrew implants. Anchorage for upper molar intrusion would be provided with a midpalatal miniscrew implant. For lower molar intrusion, anchorage would be provided by miniscrew implants placed in the inter-radicular alveolar bone.

Treatment

After extraction of the four first premolars and the three third molars, the upper and lower arches were bonded with .022/.028 preadjusted fixed appliances. A low transpalatal arch was fitted to the upper molars. A hook was soldered in the center of the loop to facilitate elastic chain application. A miniscrew implant was placed in the posterior midpalatal suture area level with the first molars under local infiltrative anesthesia. The lateral cephalogram was used for assessing the vertical bone height in the palatal suture area to determine the appropriate implant length. An OsteoMed® miniscrew (diameter 1.6 mm, length 6.0 mm) was inserted using a low-speed 256:1 contra-angle handpiece. Copious irrigation is necessary in this area to prevent cortical bone damage by the heat generated. There are no roots, nerves or blood vessels in this area to complicate the implant placement. In the lower arch, two OsteoMed® miniscrews (diameter 1.6 mm, length 6.0 mm) were placed in the inter-radicular bone of the first and second molars. Root proximity was checked on a

panoramic radiograph prior to placement. A manual screwdriver (hand driver) was used for placement. Periapical radiographs were taken after placement to verify the absence of miniscrew–root contact (Figs 7.127–7.129).



Fig. 7.127



Fig. 7.128



Fig. 7.129

Leveling and aligning of the upper and lower arches was initiated. An elastic chain was placed from the hook on the transpalatal arch to the midpalatal screw so that a vertical intrusive force was applied to the upper posterior teeth. In the lower arch, elastic chains were secured from the lower archwire between the first and second molars to the right and left buccal miniscrew implants to put an intrusive force on the lower posterior teeth. The archwires were progressively increased up to .019/.025 stainless steel, the working archwires. Space closure was begun with light and continuous forces delivered by active tiebacks from the anterior hooks on the archwire to the second molar attachment hooks (Figs 7.130–7.134). This patient was the first case of molar intrusion with use of miniscrews as anchorage. At that time the buccal

tipping of the lower posterior teeth from the intrusive force was controlled with rectangular archwire. It is preferable to place a lingual arch on the first molars than incorporating bends in the archwire.

Retraction of anterior teeth was continued by replacing the elastomeric ties at each appointment until space closure was complete. During space closure, the elastic chains connected to the miniscrews were also replaced to provide a continuous intrusive force for the upper and lower molars. The implants were stable throughout the treatment period. There was no need for vertical elastics to close the bite.

The total active treatment time was 15 months.

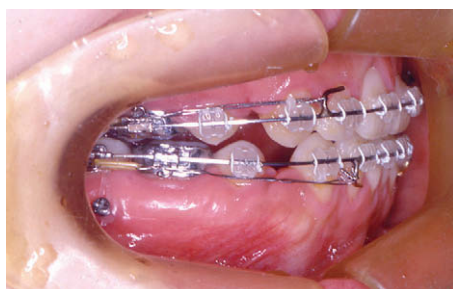


Fig. 7.130



Fig. 7.131

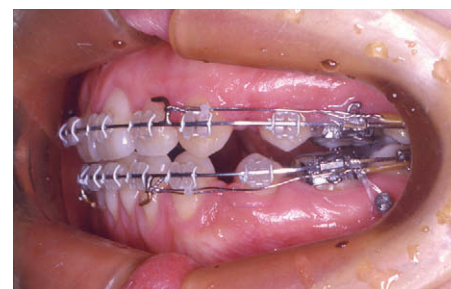


Fig. 7.132



Fig. 7.133

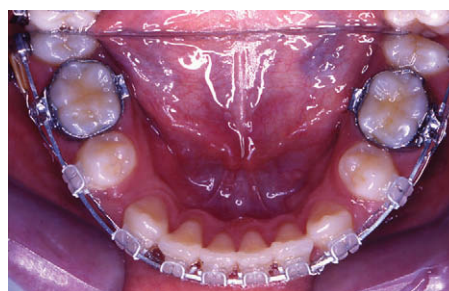


Fig. 7.134

Post-treatment evaluation

The final outcome of the treatment was a marked improvement in function and esthetics. An attractive smile was achieved with up to 80% of the upper incisors visible during smiling. The nose–lip–chin balance was greatly improved and dentoalveolar protrusion reduced with consequent decrease in the lip fullness (Figs 7.135–7.138).

Proper functioning of the anterior teeth was achieved by the establishment of appropriate contact between them, overjet and overbite. Class I canine and molar relationships were also established. Because of the large amount of distal movement and retroclination of the lower incisors, the gingival recession on the labial surfaces of the mandibular incisors slightly increased. This may have been due to the thin gingival tissue and



Fig. 7.135



Fig. 7.136



Fig. 7.137



Fig. 7.138

the root prominence present before treatment. Slight amount of residual extraction space remained in each quadrant. However, the patient requested the removal of brackets at this stage for personal reasons (Figs 7.139–7.143).

The panoramic and periapical radiographs showed that the bone levels were maintained and minimal apical root resorption was seen in the upper and lower incisors and molars (Figs 7.144–7.150).



Fig. 7.139



Fig. 7.140



Fig. 7.141

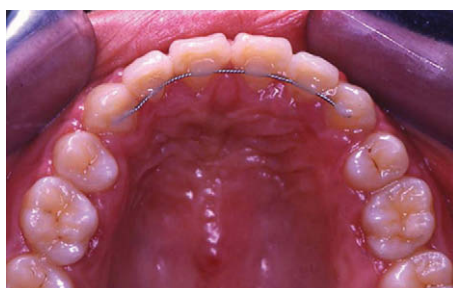


Fig. 7.142



Fig. 7.143



Fig. 7.144



Fig. 7.145

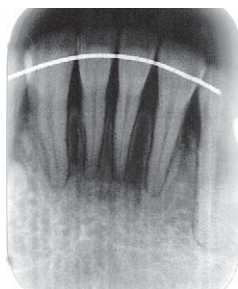


Fig. 7.146



Fig. 7.147



Fig. 7.148



Fig. 7.149



Fig. 7.150

Superimposition of the pre- and post-treatment cephalometric tracings showed 2.0 mm of posterior intrusion in both arches. The mandibular plane angle decreased by 1.2° as the mandible rotated counterclockwise with this molar intrusion. There was a reduction of 3.5 mm in the lower anterior face height and mentalis strain on lip closure disappeared. There was a slight increase in the SNB angle as the anteroposterior positions of B point and pogonion advanced about 2.0 mm. The upper incisors were retracted by 7.3 mm and retroclined by 10.5° . The lower incisors were retracted 6.0 mm and retroclined by 16.8° . The reverse curve of Spee in the lower arch was leveled through a combination of molar intrusion and incisor extrusion. Upper and lower molar position remained unchanged anteroposteriorly. The primary purpose of the miniscrew implant was to serve as anchorage for the intrusion of posterior teeth. However, it also served as anchorage for retraction of the anterior teeth, which is evidenced by the absence of detectable forward movement of the molars on the superimposition (Figs 7.151–7.153; Table 7.6).



Fig. 7.151

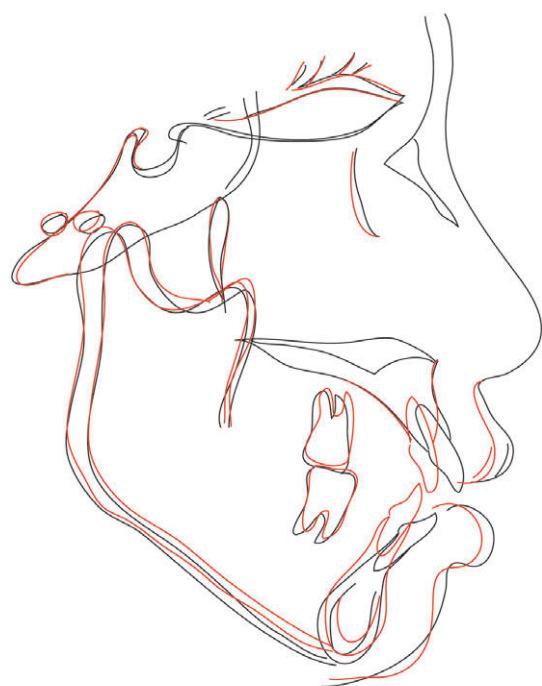


Fig. 7.152

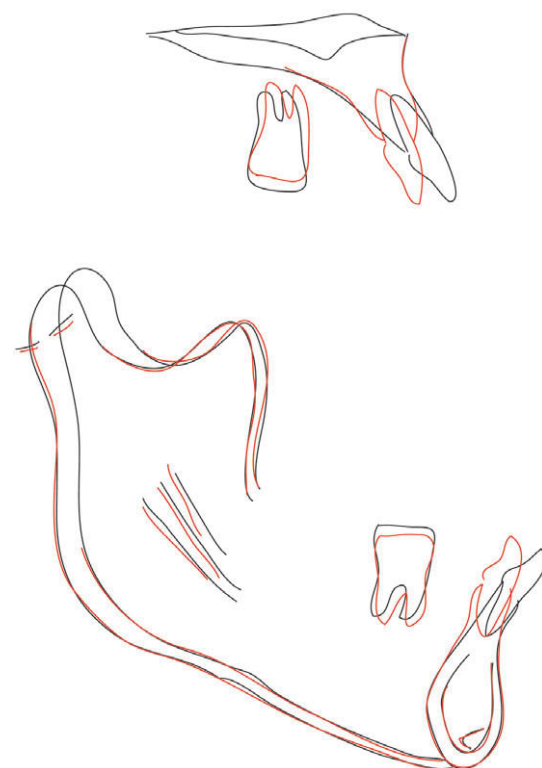


Fig. 7.153

Table 7.6 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	92.0	92.0
SNB (deg)	84.0	84.7
ANB (deg)	8.0	7.3
Vertical		
GoMe/SN (deg)	36.0	35.0
FMPA (deg)	29.2	28.0
PP/MP (deg)	28.0	26.6
Lower gonial (deg)	79.4	77.5
ANS–Me (mm)	81.3	77.8
DENTAL ANALYSIS		
Overjet (mm)	3.6	2.6
Overbite (mm)	–7.2	2.0
UI/SN (deg)	111.5	101.0
L1/GoMe (deg)	103.8	87.0
SN/OP (deg)	20.5	16.0
Is–Is' (mm)	33.8	34.0
Mo–Ms (mm)	32.0	30.0
li–li' (mm)	46.7	47.0
Mo–Mi (mm)	42.0	40.0
LIP ANALYSIS		
U Lip–E (mm)	3.4	0.0
L Lip–E (mm)	7.1	4.2
NLA (deg)	86.0	90.0

See page ix for Korean norms.

See Table 7.1 and page x for abbreviations.

A new set of records taken 3 years and 3 months after retention showed no remarkable changes in the anterior overbite. There was a slight opening of the extraction sites because the patient was not fully compliant with retainer wear. The substantial amount of incisor retraction over a relatively short period of treatment time in this case may also have contributed to opening of the extraction spaces after appliance removal (Figs 7.154–7.163).

Discussion

Skeletal open bite is considered to be one of the most difficult problems to correct with orthodontic treatment alone because of the multiple etiological factors¹⁸ and

instability of the correction.⁸ For growing patients, treatment approaches that aim to restrain vertical maxillary growth and control the eruption of posterior teeth in both arches are recommended.¹⁹ However, appliances that apply intrusive forces to upper and lower posterior teeth have been described as providing less consistent results.⁸

Extrusion of anterior teeth via elastics is another method of overbite reduction. However, extruded teeth are unstable.²⁰ Elastic wear can extrude anterior teeth beyond the limits of eruption and may consequently lead to redevelopment of the open bite due to stretched gingival fibers. Subtelny suggested that intrusion of the maxillary and mandibular molars is more beneficial in closing the anterior open bite.¹⁸

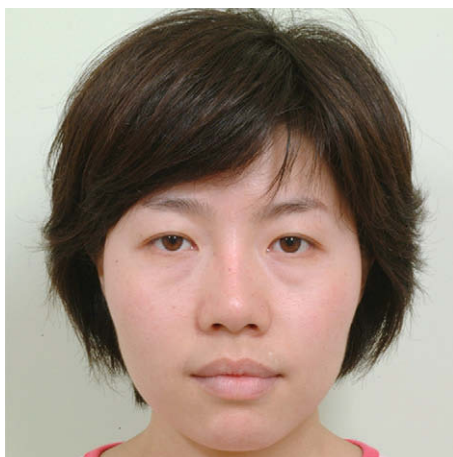


Fig. 7.154

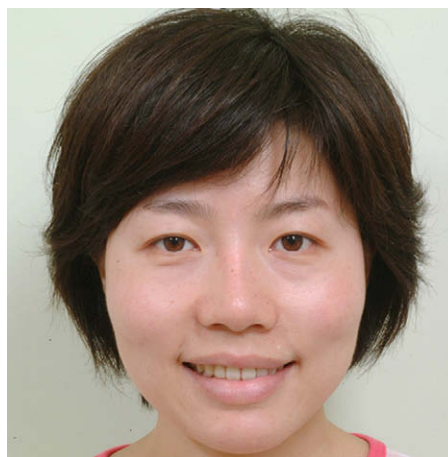


Fig. 7.155



Fig. 7.156



Fig. 7.157



Fig. 7.158



Fig. 7.159



Fig. 7.160



Fig. 7.161



Fig. 7.162



Fig. 7.163

In adults with open bite, merely preventing the extrusion of posterior teeth during orthodontic treatment is inadequate and actual intrusion of posterior teeth may be necessary. Rigid anchorage for orthodontic intrusion of posterior teeth is difficult with conventional treatment mechanics, requiring complex appliance designs to reinforce the anchorage.¹¹ Open bite closure in adult patients may also require orthognathic surgery to reposition the posterior teeth superiorly to restore anterior function. However, even surgery does not always guarantee stability.²¹

Intrusion of molars in both jaws is desirable to correct the severe anterior open bite. The effect of intrusion of molars in only one jaw may be negated by extrusion of molars in the opposite jaw. In the adult patient who refuses surgery and requires intrusion of upper and lower posterior teeth to close an open bite, miniscrew implant anchorage can serve as a stable source of anchorage to intrude the posterior teeth.

CASE 7.4

Unilateral intrusion of upper posterior teeth in a patient with asymmetric skeletal Class III malocclusion

Presenting complaint and clinical examination

A 21-year-old Korean man presented with a chief complaint of facial asymmetry. There was history of injury to his left temporomandibular joint following a fall in childhood. On frontal view, his chin point and

mandible were deviated to the right side. His lips and upper occlusal plane were canted. He had a straight profile. He was a mouth breather and had a mild lisp (Figs 7.164–7.167).



Fig. 7.164



Fig. 7.165



Fig. 7.166



Fig. 7.167

On intraoral examination, the upper dental midline was centered in relation to the facial midline but the lower dental midline was deviated 6.0 mm to the right side. There was a posterior crossbite on the right side. There was a Class II canine and Class III molar relationship on the right side and Class III canine and molar relationships on the left side. The overjet was -2.5 mm. There was a minor upper and lower anterior crowding (Figs 7.168–7.173).

Premature contact was present on upper and lower right canines when the mandible was guided into centric relation. A mandibular shift to the right side

was detected on closure. There were no signs or symptoms of temporomandibular joint disorder.

Radiographic evaluation

The panoramic radiograph revealed a full complement of teeth except for the left upper and lower third molars. The upper and lower right third molars were impacted. The lower left third molar had been extracted at another clinic prior to consultation. Slight horizontal alveolar bone loss was evident. The distance from the condylar head to the antegonial notch was greater on the left side by 8.0 mm (Fig. 7.174).



Fig. 7.168



Fig. 7.169



Fig. 7.170



Fig. 7.171

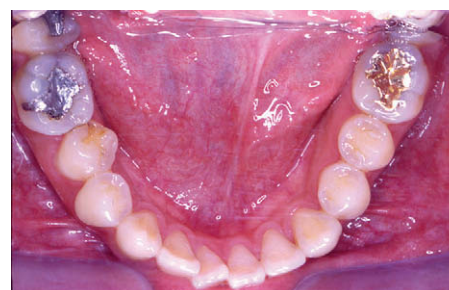


Fig. 7.172

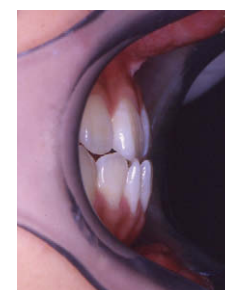


Fig. 7.173

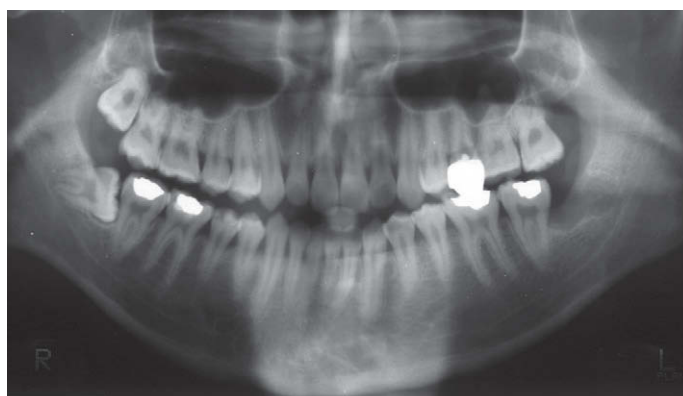


Fig. 7.174

Cephalometric analysis revealed a skeletal Class III relationship with prognathic mandible. The maxillary incisors were proclined and the upper lip was retrusive relative to the E line (Fig. 7.175; Table 7.7).



Fig. 7.175

On the PA cephalogram, the left first molar was 2.0 mm inferior to the right first molar. Mandible deviation to right side was evident (Fig. 7.176).

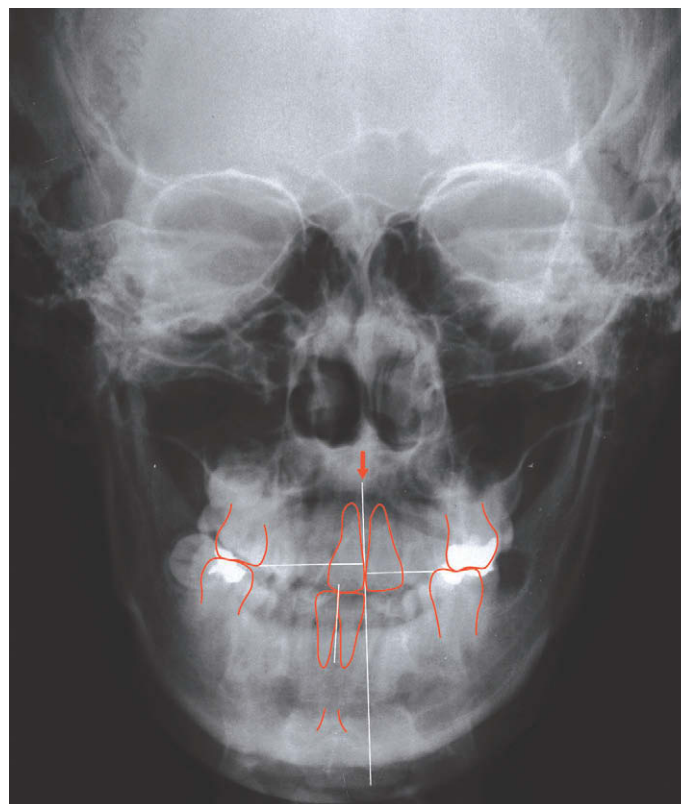


Fig. 7.176

Table 7.7 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	83.0
SNB (deg)	84.0
ANB (deg)	−1.0

Vertical

GoMe/SN (deg)	31.0
FMPA (deg)	26.5
PP/MP (deg)	20.0
Lower gonial (deg)	76.0
ANS–Me (mm)	71.5

DENTAL ANALYSIS

Overjet (mm)	−2.5
Overbite (mm)	1.0
UI/SN (deg)	113.5
L1/GoMe (deg)	91.0
SN/OP (deg)	15.0
Is–Is' (mm)	28.0
Mo–Ms (mm)	27.0
Ii–Ii' (mm)	44.0
Mo–Mi (mm)	35.5

LIP ANALYSIS

U Lip–E (mm)	−3.5
L Lip–E (mm)	1.0
NLA (deg)	92.0

See page ix for Korean norms.
See Table 7.1 and page x for abbreviations.

Treatment objectives and plan

The objectives of the treatment were to establish facial symmetry, align the upper and lower dental midlines in relation to the facial midline, and correct the occlusal canting.

The provisional treatment plan presented to the patient was a combination of orthodontic treatment and orthognathic surgery to correct the facial asymmetry. The surgical plan consisted of a LeFort I osteotomy to correct maxillary canting and bilateral sagittal split osteotomy for asymmetric setback of the mandible. Extraction of remaining third molars would be done prior to surgery.

For financial reasons, the patient could have only the lower jaw surgery. So an alternative plan was presented, which included intrusion of the upper left posterior teeth via palatal alveolar miniscrew implant anchorage. This would level the occlusal plane and maxillary surgery would be avoided. The surgical treatment would be limited to asymmetric mandible setback via bilateral sagittal split osteotomy.

Treatment

After extraction of the upper and lower right third molars, a transpalatal arch was fitted on the upper first molars. A hook was soldered on the palatal side of the left molar band to facilitate elastic chain application. The transpalatal arch was expanded before cementation. The upper and lower arches were bonded with .022/.028 preadjusted fixed appliances. Leveling and aligning of upper and lower arches was initiated.

Miniscrew placement and further treatment

The archwires were progressively increased up to .019/.025 stainless steel working wires. An OSAS® miniscrew implant (diameter 1.6 mm, length 8.0 mm) was placed in the palatal alveolar bone between the left first and second molar palatal roots using a 256:1 contra-angle handpiece. The thickness of the soft tissue in this area was checked and the appropriate miniscrew

length was selected. The palatal approach reduced the possibility of miniscrew–root contact during miniscrew placement because of the sufficient inter-radicular space in the palatal side. However, care should be taken not to penetrate the greater palatine vessels. A week after miniscrew placement, a chain was placed from the hook on the transpalatal arch to the miniscrew so that a vertical intrusive force was applied to the upper left posterior teeth (Figs 7.177–7.182).



Fig. 7.177



Fig. 7.178



Fig. 7.179



Fig. 7.180

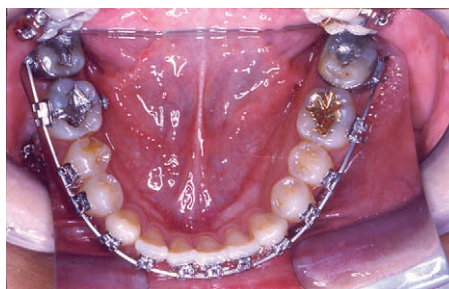


Fig. 7.181



Fig. 7.182

The elastic chain attached to the miniscrew was replaced at each appointment to provide a continuous intrusive force to the upper left molars. Nine months into treatment the patient was ready for mandibular surgery. A PA cephalogram was taken to assess the intrusion of left upper molar. The difference in the right and left molar height was 1.0 mm, but now the left molar was superiorly positioned compared with the right (Fig. 7.183).

Mandibular setback surgery was carried out. The miniscrew remained stable throughout the treatment period and was removed after applying a topical anesthetic. The total active treatment time was 13 months. Immediately after bracket removal, lingual bonded retainers were placed (from canine to canine in the lower arch and on the upper left central and lateral incisors). Upper and lower Hawley retainers were inserted on the following appointment.



Fig. 7.183

Post-treatment evaluation

The post-treatment photographs showed that the facial asymmetry and lip canting although still present were reduced. The maxillary occlusal plane was leveled and the chin point centered. Upper and lower dental

midlines were aligned with the facial midline. Class I canine and molar relationships with optimum overjet and overbite were established (Figs 7.184–7.194).



Fig. 7.184



Fig. 7.185



Fig. 7.186



Fig. 7.187



Fig. 7.188



Fig. 7.189



Fig. 7.190



Fig. 7.191



Fig. 7.192



Fig. 7.193



Fig. 7.194

The post-treatment PA cephalogram showed the vertical difference between the right and left first molars was 0.8 mm, with the left molar superiorly positioned (Figs 7.195–7.198; Table 7.8).

Table 7.8 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements			
	Pretreatment		Post-treatment
SKELETAL ANALYSIS			
Anteroposterior			
SNA (deg)	83.0		83.5
SNB (deg)	84.0		83.0
ANB (deg)	−1.0		0.5
Vertical			
GoMe/SN (deg)	31.0		34.0
FMPA (deg)	26.5		29.0
PP/MP (deg)	20.0		23.0
Lower gonial (deg)	76.0		77.0
ANS–Me (mm)	71.5		71.5
DENTAL ANALYSIS			
Overjet (mm)	−2.5		2.5
Overbite (mm)	1.0		1.0
UI/SN (deg)	113.5		115.5
L1/GoMe (deg)	91.0		84.0
SN/OP (deg)	15.0		14.0
Is–Is' (mm)	28.0		28.0
Mo–Ms (mm)	27.0		27.0
Ii–Ii' (mm)	44.0		44.0
Mo–Mi (mm)	35.5		34.0
LIP ANALYSIS			
U Lip–E (mm)	−3.5		−3.0
L Lip–E (mm)	1.0		−2.0
NLA (deg)	92.0		92.0
See page ix for Korean norms. See Table 7.1 and page x for abbreviations.			



Fig. 7.195



Fig. 7.196

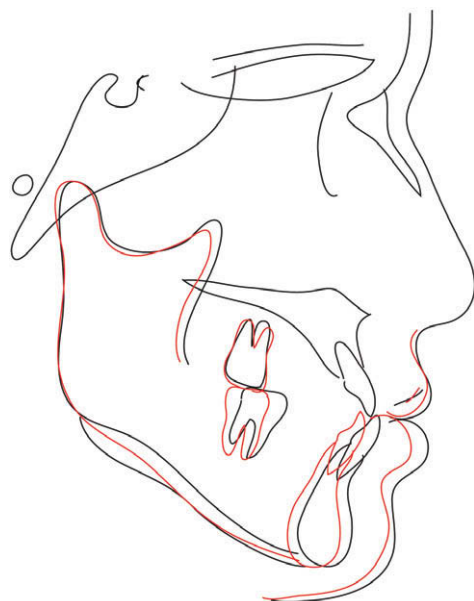


Fig. 7.197

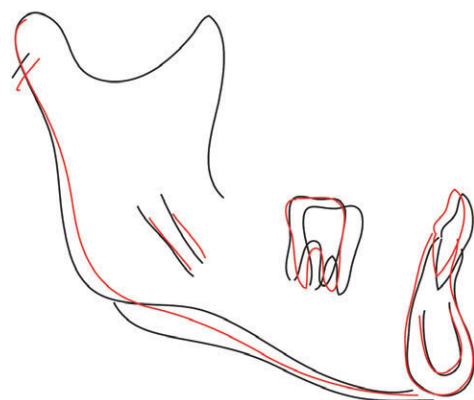
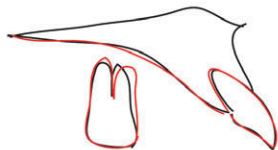


Fig. 7.198

Discussion

In this patient, asymmetric intrusion of posterior teeth allowed mandibular setback surgery to be carried out without the need of concurrent maxillary surgery. Thus with the help of miniscrew implant anchorage, an acceptable result was achieved by using less extensive surgical procedures and at a lower cost.

MINISCREW IMPLANT ANCHORAGE FOR INTRUSION OF ANTERIOR TEETH

Orthodontic correction of deep overbite can be achieved with several mechanisms that result in true intrusion of anterior teeth, extrusion of posterior teeth, or a combination of both. With miniscrew implant anchorage, treatment mechanics for the intrusion of anterior teeth are simplified and intrusive movement is more efficient.

Intrusion of anterior teeth to correct deep overbite may be indicated in patients with unesthetic, excessive maxillary incisor show when the lips are in repose. Traditionally, a utility archwire has been used for intrusion in such cases. Light continuous force is applied during intrusion to minimize root resorption. The intrusive force is applied anterior to the center of resistance of the incisors, and therefore the incisors tend to tip forward as they intrude. Even by controlling posterior anchorage by placing a rectangular arch and a lingual arch, the reaction to the intrusion of incisors is extrusion and distal tipping of the posterior segments. When a miniscrew implant is used to intrude anterior teeth, there is no reactive force on the posterior teeth. Thus true intrusion of anterior teeth is easily achieved with no adverse effects on the posterior teeth from reciprocal forces.

CASE 7.5

Intrusion of maxillary anterior teeth in a patient with excessive incisor display

Presenting complaint and clinical examination

A 12-year-old Korean boy presented with the chief complaint of gummy appearance and anterior crowding. On smiling, the full clinical crowns of his

upper anterior teeth and 3.0 mm of gingiva were visible. He had a straight profile and his lips were slightly protrusive (Figs 7.199–7.202).



Fig. 7.199



Fig. 7.200



Fig. 7.201



Fig. 7.202

On intraoral examination there was 100% overbite (that is, the lower central incisors were not visible in centric occlusion). There was some inflammation of the gingival tissue behind the maxillary incisors. The lower incisors were lingually inclined and the upper and lower left lateral incisors were in crossbite. There was Class II canine and molar relationships on the

right side. The upper first molars were mesially rotated and there was lack of space for the eruption of the upper right second premolar. There was a moderate arch length discrepancy with anterior crowding in the lower arch, and the lower arch form was distorted (Figs 7.203–7.208).



Fig. 7.203



Fig. 7.204



Fig. 7.205



Fig. 7.206



Fig. 7.207



Fig. 7.208

Radiographic evaluation

The panoramic radiograph revealed a full complement of teeth and there were no abnormal findings. Cephalometric analysis revealed a skeletal Class I relationship with deep anterior overbite. The upper central incisors were extruded with the incisal edges 8–9 mm below the lower lip. The overbite was 10.0 mm. Both the upper and the lower incisors were lingually inclined (Fig. 7.209; Table 7.9).



Fig. 7.209

Table 7.9 Pretreatment dental and facial cephalometric measurements

SKELETAL ANALYSIS

Anteroposterior

SNA (deg)	83.0
SNB (deg)	80.0
ANB (deg)	3.0

Vertical

GoMe/SN (deg)	34.0
FMPA (deg)	27.0
PP/MP (deg)	21.5
Lower gonial (deg)	75.0
ANS–Me (mm)	62.0

DENTAL ANALYSIS

Overjet (mm)	5.5
Overbite (mm)	10.0
UI/SN (deg)	93.0
L1/GoMe (deg)	72.0
SN/OP (deg)	20.5
Is–Is' (mm)	30.0
Mo–Ms (mm)	22.0
Ii–Ii' (mm)	40.0
Mo–Mi (mm)	31.0

LIP ANALYSIS

U Lip–E (mm)	1.2
L Lip–E (mm)	2.1
NLA (deg)	95.0

See page ix for Korean norms.
See Table 7.1 and page x for abbreviations.

Treatment objectives and plan

Non-extraction orthodontic treatment was planned with the primary objective of reducing the deep anterior overbite. A miniscrew implant would be placed between the upper central incisor roots to serve as anchorage for intrusion of the overerupted upper anterior teeth.

Treatment

The upper incisors were bonded with .022/.028 preadjusted fixed appliances and aligned and leveled with a sectional .019/.025 stainless steel archwire.

The transverse width of the inter-radicular bone between the upper central incisors was evaluated on a periapical radiograph prior to miniscrew implant placement (Fig. 7.210). This distance increases from the alveolar crest toward the apex of the teeth. Therefore, as the upper central incisors are intruded, the initial vertical distance between the archwire and the implant is expected to decrease and roots come closer to the miniscrew implant. It is therefore important that the miniscrew implant is placed sufficiently apical.

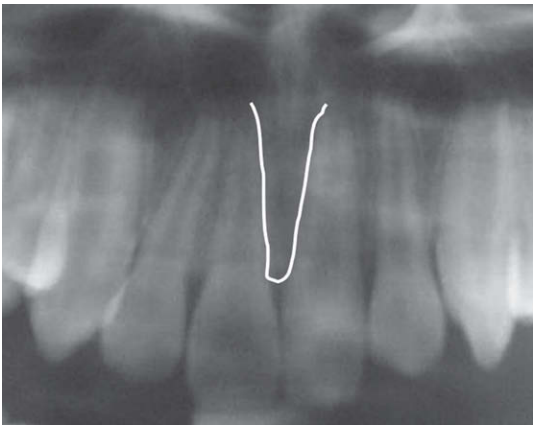


Fig. 7.210

Surgical procedure for miniscrew placement and further treatment

Under infiltrative local anesthesia, the upper lip was elevated and an incision made in the labial frenum. The bone was exposed with a periosteal elevator. An OSAS® miniscrew implant (diameter 1.6 mm, length 6.0 mm) was placed with a manual screwdriver (hand driver). A nickel-titanium (NiTi) closed coil spring was ligated to the head of the implant and stretched and the other end ligated to the upper archwire. The miniscrew and

the upper portion of the closed coil spring were covered by the flap of mucosa, which was sutured. Even if the miniscrew implant is left exposed, it will eventually get covered by mucosa during healing. Moreover, exposed miniscrews often cause soft tissue irritation, but this does not happen with the miniscrew buried under the soft tissue. When it is planned to place the implant in the movable vestibular mucosa, the 'closed' type is recommended (see Chapter 5 for details of closed-pull and open-pull methods) (Figs 7.211–7.216).



Fig. 7.211



Fig. 7.212



Fig. 7.213

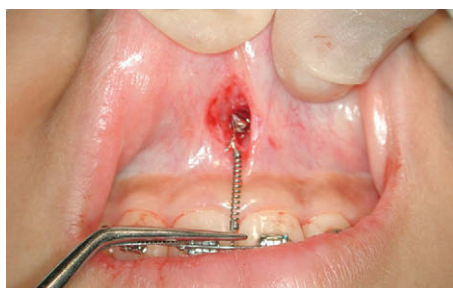


Fig. 7.214



Fig. 7.215

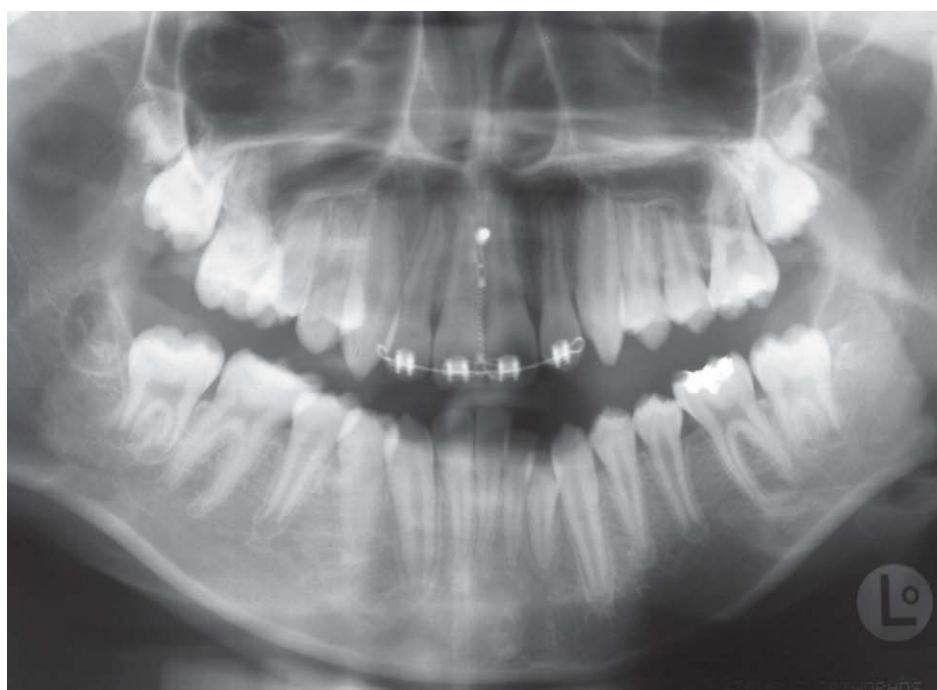


Fig. 7.216

Intrusion of the incisors was started 2 weeks after the miniscrew was placed. The upper incisors were expected to not only intrude but also to procline as intrusion progressed (Figs 7.217–7.220).



Fig. 7.217



Fig. 7.218



Fig. 7.219

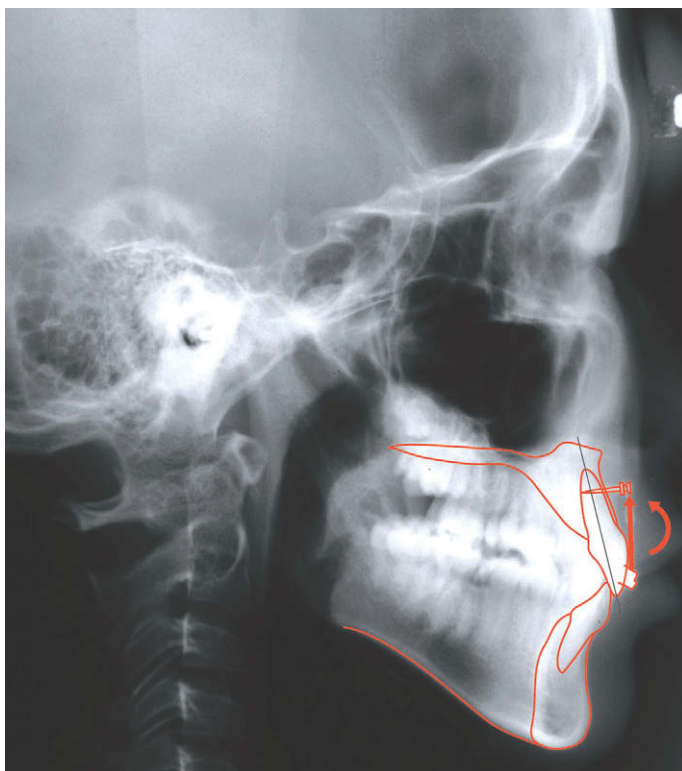


Fig. 7.220

At 3 months, there was a marked discrepancy between the incisal level of the incisors and the tips of the canines (Figs 7.221–7.223). An interim cephalogram demonstrated the proclination of the upper incisors (Fig. 7.224).



Fig. 7.221

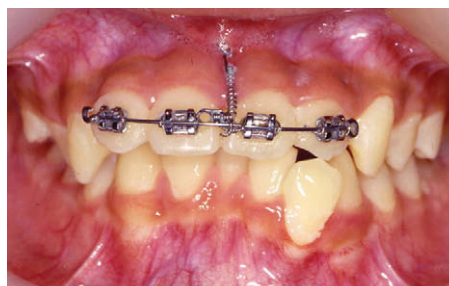


Fig. 7.222



Fig. 7.223

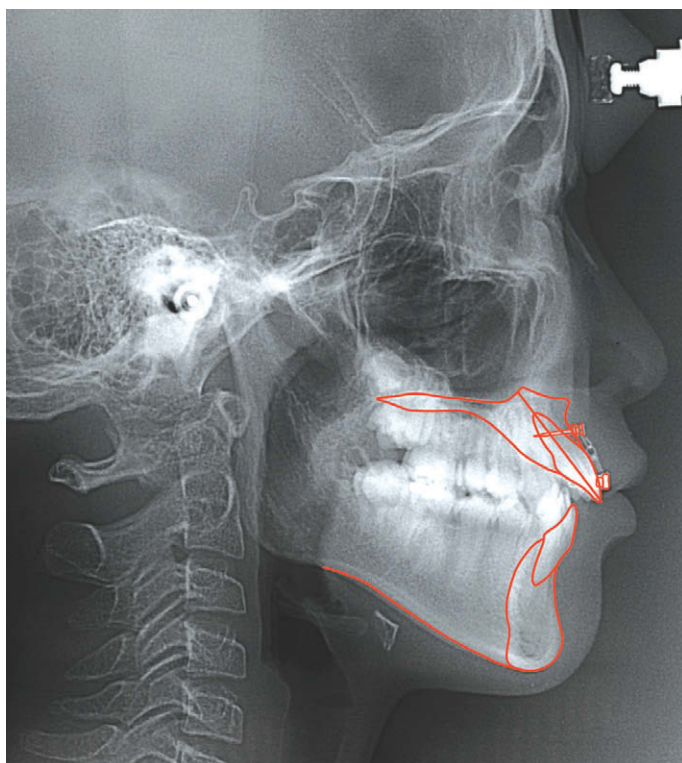


Fig. 7.224

At 6 months, .022/.028 preadjusted fixed appliances were bonded on the remaining teeth in the upper arch. A .018/.025 stainless steel utility archwire and an .014 NiTi overlay wire were tied in. The .014 NiTi was replaced by an .018 NiTi wire at the following appointment. A steel ligature was passively tied from

the miniscrew to the utility archwire to prevent extrusion of the incisors (Figs 7.225–7.228).

At 11 months, the NiTi coil spring was replaced with a passive steel ligature tie. A continuous .016/.022 NiTi archwire was inserted in the upper arch (Figs 7.229–7.232). During this time, compared with the



Fig. 7.225



Fig. 7.226



Fig. 7.227



Fig. 7.228



Fig. 7.229



Fig. 7.230



Fig. 7.231



Fig. 7.232

pretreatment condition of the lower dentition, the anterior part of the lower arch form had changed without any orthodontic force application. The previously distorted arch form was now U shaped (Figs 7.233, 7.234). This was because as the restricting effect of upper incisors was removed, the lower incisors moved labially. A Burstone lingual arch was placed to apply buccal crown torque.

The lower teeth were bonded with .022/.028 preadjusted fixed appliances. Leveling and aligning of the teeth was carried out and archwires progressively increased in size (Figs 7.235–7.237).



Fig. 7.233



Fig. 7.234



Fig. 7.235



Fig. 7.236



Fig. 7.237

Post-treatment evaluation

Gum exposure was reduced on smiling and there was 50% exposure of the clinical crowns of the lower incisors in centric occlusion (Figs 7.238–7.248).

The panoramic and periapical radiographs showed that bone level was maintained. There was minimal apical root resorption of the upper incisors (Fig. 2.249).

Superimposition of the pre- and post-treatment cephalometric tracings showed intrusion and considerable proclination of the upper incisors. The lower incisors proclined considerably without any direct application of orthodontic force and normal axial inclination was achieved. Marked downward and forward mandible growth was also observed during the treatment period and this assisted overbite reduction (Figs 7.250–7.252; Table 7.10).

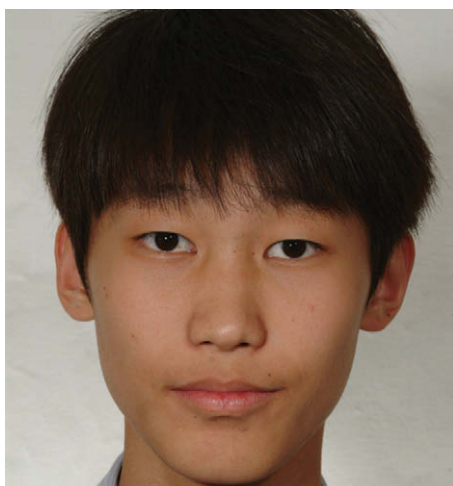


Fig. 7.238

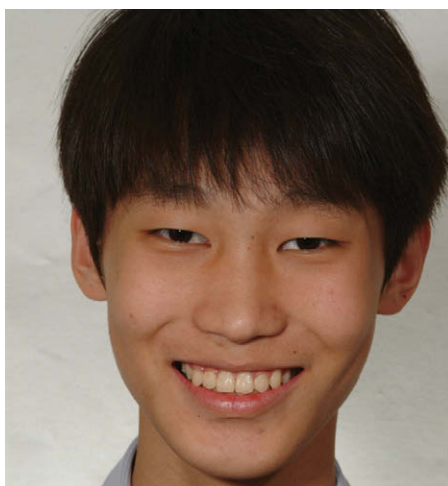


Fig. 7.239



Fig. 7.240



Fig. 7.241



Fig. 7.242



Fig. 7.243



Fig. 7.244



Fig. 7.245



Fig. 7.246



Fig. 7.247



Fig. 7.248



Fig. 7.249



Fig. 7.250

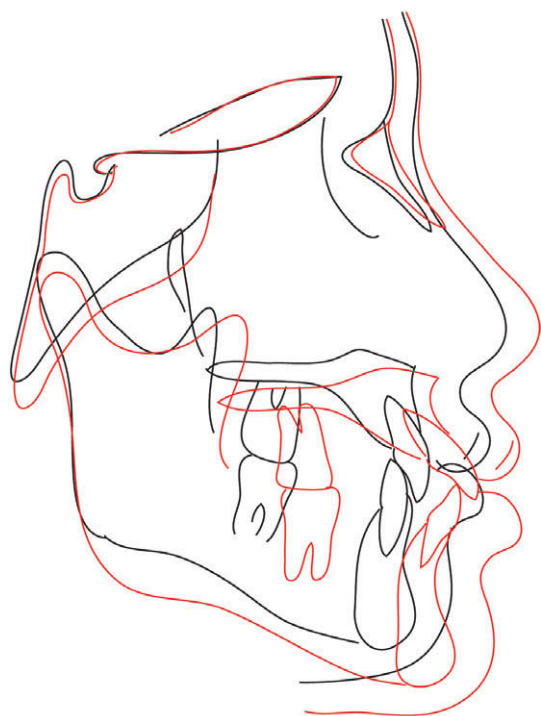


Fig. 7.251

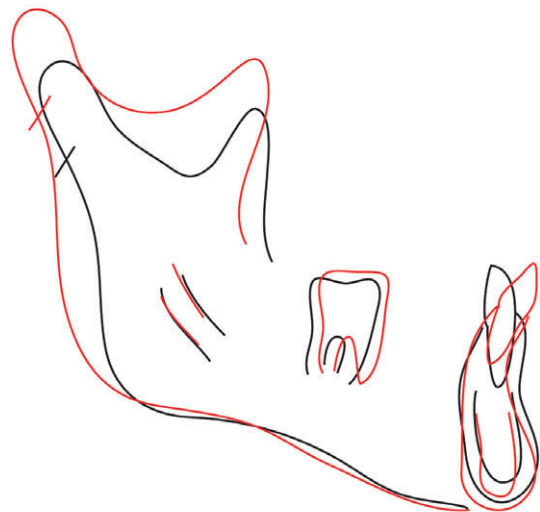
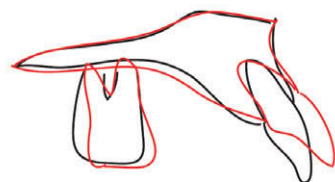


Fig. 7.252

Table 7.10 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	83.0	86.0
SNB (deg)	80.0	83.0
ANB (deg)	3.0	3.0
Vertical		
GoMe/SN (deg)	34.0	30.0
FMPA (deg)	27.0	27.0
PP/MP (deg)	21.5	24.0
Lower gonial (deg)	75.0	74.0
ANS–Me (mm)	62.0	67.0
DENTAL ANALYSIS		
Overjet (mm)	5.5	3.8
Overbite (mm)	10.0	3.0
UI/SN (deg)	93.0	116.0
L1/GoMe (deg)	72.0	95.5
SN/OP (deg)	20.5	12.0
Is–Is' (mm)	30.0	27.0
Mo–Ms (mm)	22.0	22.0
li–li' (mm)	40.0	44.0
Mo–Mi (mm)	31.0	34.5
LIP ANALYSIS		
U Lip–E (mm)	1.2	–1.2
L Lip–E (mm)	2.1	2.0
NLA (deg)	95.0	96.0

See page ix for Korean norms.
See Table 7.1 and page x for abbreviations.

At 2 year follow-up a new set of records was taken. There were no remarkable changes in the anterior overbite (Figs 7.253–7.263).

These cases collectively illustrate the effectiveness, relative simplicity and versatility of miniscrews in achieving intrusive tooth movements, which are acknowledged to be among the most difficult tooth movements to achieve.



Fig. 7.253

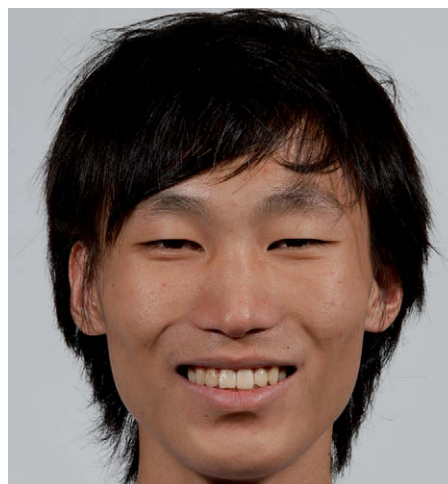


Fig. 7.254



Fig. 7.255



Fig. 7.256



Fig. 7.257



Fig. 7.258



Fig. 7.259



Fig. 7.260

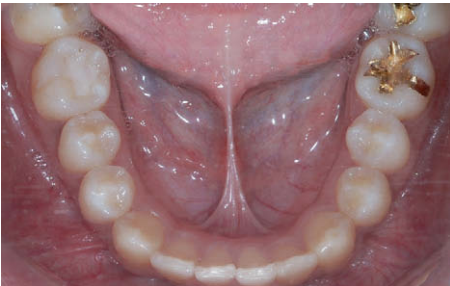


Fig. 7.261



Fig. 7.262



Fig. 7.263

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MINISCREW IMPLANT ANCHORAGE FOR TRANSVERSE AND ASYMMETRIC TOOTH MOVEMENT

Transverse and asymmetric tooth movement	212
CASE 8.1 Unilateral transverse expansion of posterior teeth	213
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TRANSVERSE AND ASYMMETRIC TOOTH MOVEMENT

Transverse discrepancy of the arches is expressed as unilateral or bilateral crossbite of the posterior teeth. Transverse movement of maxillary posterior teeth to correct a transverse bilateral discrepancy or a unilateral crossbite with a mandibular displacement can be readily achieved via symmetric expansion with many expansion appliances such as the W-arch, quadhelix and the rapid palatal expander. However, unilateral expansion is inherently more difficult and complicated, because of the undesired reciprocal expansion on one side. One way to combat this transverse loss of anchorage is to make the lateral arms of a W-arch of different lengths to create differential root surface areas on the two sides and just move selected teeth on the side requiring expansion. Another source of anchorage is to use the mandibular lingual arch to stabilize the lower teeth and then use cross-elastics on the side that needs to be corrected. Nevertheless, the reciprocal force will still tend to move the anchor teeth and both sides will show expansion. Use of a lingual arch with buccal root torque (lingual crown torque) on one side and buccal tipping on the other side is another option. There are limits to the possibilities with all these treatment mechanics.

With miniscrew implant anchorage, unilateral expansion is more readily achievable, because secure, cooperation-free anchorage can be obtained on one side. The appliance is activated as usual on the side to be expanded and is passively tied to the miniscrew on the side that does not need expansion. Case 8.1 demonstrates these mechanics in action.

Other situations requiring asymmetric tooth movement, either in the anteroposterior or vertical

direction can benefit in the same way from the incorporation of miniscrew anchorage into the orthodontic treatment plan. Some dental midline discrepancies are difficult to correct with conventional orthodontic mechanics. Approaches such as asymmetric headgear or asymmetric intermaxillary elastic wear are usually used, but they rely on excellent patient compliance. In addition, elastic wear may have undesirable effects such as the bilateral extrusion of the posterior teeth with increase in vertical dimension and concurrent clockwise rotation of the mandible or an asymmetric effect on the overbite. Asymmetric extraction of teeth is one option that minimizes patient compliance in cases of severe dental midline discrepancy when extraction treatment is being considered. However, correction of dental midline discrepancy is simplified with miniscrew implant anchorage, whether extraction or non-extraction treatment has been planned. A miniscrew is placed on the side toward which the teeth need to be moved and a traction force is applied in the desired direction. No intermaxillary elastics, i.e. parallel or anterior diagonal elastics, are needed. The midline is not corrected at the expense of tooth movement in the opposing arch, and side effects from the reciprocal force reaction are eliminated. If teeth will need to be moved toward or actually past the miniscrew, the miniscrew should be placed more apically and/or with vertical angulation in the alveolar bone to reduce the risk of miniscrew–root contact as the anterior teeth move. Case 8.2 is an example of the use of such mechanics.

Miniscrew implant anchorage can also be used to correct a canted anterior occlusal plane by intrusion of selected anterior teeth. Once again, the advantages of miniscrews are simplicity of design and effective asymmetric movement. Case 8.3 is an example of such mechanics in action.

CASE 8.1

Unilateral transverse expansion of posterior teeth

Presenting complaint and clinical examination

A 46-year-old Korean man presented with spacing and lower anterior crowding. He had a unilateral posterior crossbite on the right side (Figs 8.1, 8.2). There was no mandibular displacement on closure in centric relation.

Treatment objectives and plan

The treatment objectives included correction of the posterior crossbite, and transverse expansion was planned.

Treatment

An activated W-arch was cemented on the upper first molars. An OSAS® miniscrew implant (diameter 1.6 mm, length 6.0 mm) was placed in the palatal bone between the left first and second molars. The left side of the W-arch was tied to the miniscrew implant with a ligature wire to prevent the left posterior teeth from moving buccally. The palatal miniscrew was covered with composite to minimize irritation (Figs 8.3, 8.4).



Fig. 8.1



Fig. 8.2



Fig. 8.3



Fig. 8.4

The upper dentition was bonded with .018 Ormco® lingual brackets and the lower dentition with .022/.028 preadjusted brackets. Leveling and aligning were carried out (Figs 8.5, 8.6).



Fig. 8.5



Fig. 8.6

Post-treatment evaluation

Unilateral transverse expansion of the upper arch was achieved and the posterior crossbite on the right side corrected. There was no reciprocal expansion on the left side (Figs 8.7–8.8).



Fig. 8.7



Fig. 8.8

CASE 8.2

Correction of lower dental midline discrepancy in a patient with Class I malocclusion and lip protrusion

Presenting complaint and clinical examination

A 14-year-old Korean boy presented with upper anterior protrusion, a convex profile and facial asymmetry with a recessive chin deviating to the left

side. Both upper and lower lips were protrusive with mentalis strain on lip closure (Figs 8.9–8.12). He was a mouth breather.



Fig. 8.9



Fig. 8.10



Fig. 8.11

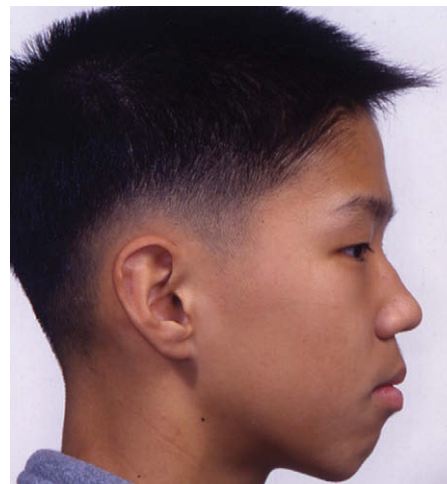


Fig. 8.12

Intraoral examination showed generally large teeth, minor upper and lower anterior crowding and Class III canine and molar relationships on the right side and Class II canine and molar relationships on the left side. The right upper and lower second premolars were in scissors bite and the left upper second premolar was in crossbite. The upper dental midline was coincident with the facial midline but the lower dental midline was 2.2 mm to the left. The overjet was 5.5 mm. The upper arch was V shaped (Figs 8.13–8.17).

Radiographic evaluation

The panoramic radiograph revealed a full complement of teeth including the four developing third molars (Fig. 8.18). Cephalometric analysis revealed a skeletal Class I relationship, with proclined upper incisors. The lips were protrusive relative to the E (esthetic) line. The upper anterior and posterior dentoalveolar heights



Fig. 8.13



Fig. 8.14



Fig. 8.15



Fig. 8.16

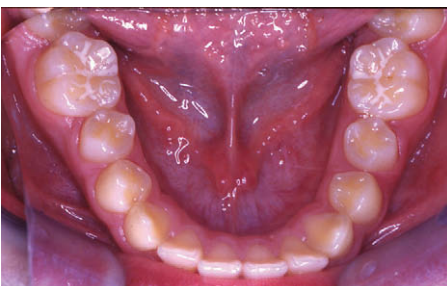


Fig. 8.17



Fig. 8.18

(Is–Is', Mo–Ms, see Table 8.1 footnote for explanation), the palatal to mandibular planes, lower gonial and GoMe/SN angles were increased. The lower anterior

facial height was also excessive (Fig. 8.19). The PA cephalogram showed the mandible to be asymmetric with the chin to the patient's left (Fig. 8.20).

Table 8.1 Pretreatment dental and facial cephalometric measurements	
SKELETAL ANALYSIS	
Anteroposterior	
SNA (deg)	82.0
SNB (deg)	78.0
ANB (deg)	4.0
Vertical	
GoMe/SN (deg)	40.0
FMPA (deg)	33.0
PP/MP (deg)	32.0
Lower gonial (deg)	79.0
ANS–Me (mm)	76.5
DENTAL ANALYSIS	
Overjet (mm)	5.5
Overbite (mm)	1.0
UI/SN (deg)	117.5
L1/GoMe (deg)	93.0
SN/OP (deg)	18.0
Is–Is' (mm)	33.0
Mo–Ms (mm)	27.0
li–li' (mm)	49.0
Mo–Mi (mm)	36.0
LIP ANALYSIS	
U Lip–E (mm)	3.5
L Lip–E (mm)	7.5
NLA (deg)	76.0
See page ix for Korean norms.	
Is–Is' Upper anterior dentoalveolar height (UI–NF)	
li–li': Lower anterior dentoalveolar height (LI–GoMe)	
Mo–Ms: Upper posterior dentoalveolar height (U6–NF)	
Mo–Mi: Lower posterior dentoalveolar height (L6–GoMe)	



Fig. 8.19

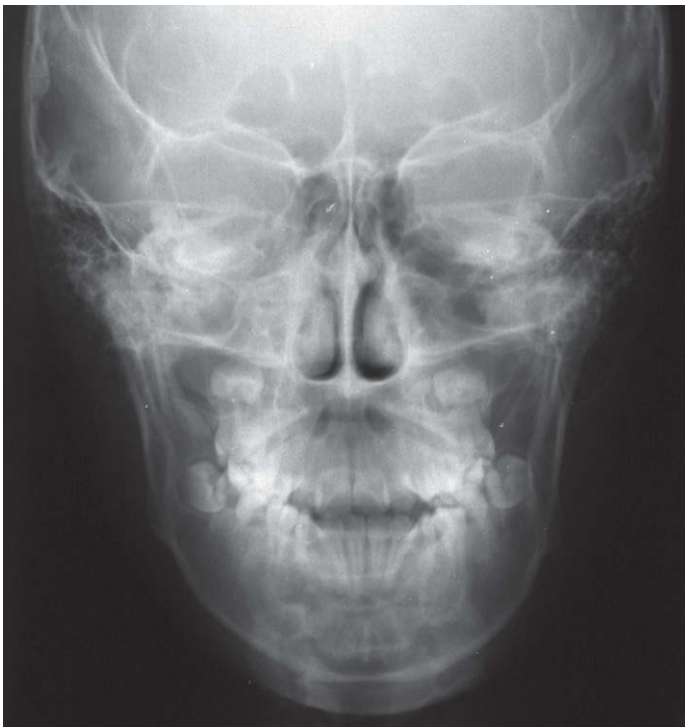


Fig. 8.20

Treatment objectives and plan

The treatment plan was to extract the maxillary first premolars and mandibular second premolars to help reduce the dentoalveolar protrusion. Anchorage support for intrusion and retraction of upper dentition was planned via midpalatal miniscrew implants. Another miniscrew implant would be placed in the right lower buccal alveolar bone to serve as anchorage during correction of the mandibular dental midline.

Treatment

Following extraction of the premolars, a transpalatal arch was fitted on the maxillary first molars. Both arches were bonded with .022/.028 preadjusted fixed appliances and leveling and aligning started. The

archwires were progressively increased up to .019/.025 stainless steel working archwires.

At 5 months, under infiltration anesthesia, a miniscrew implant (OsteoMed®; diameter 1.6 mm, length 6.0 mm) was placed in the midpalatal suture area level with the second premolars anteroposteriorly. As the midpalatal suture is not fully ossified in a growing patient, placing the miniscrew slightly off-center, 1.5 mm in this patient, yields superior retention of the screw. Kobayashi hooks were bonded on both sides of the transpalatal arch with composite adhesive. A stainless steel ligature wire was tied around the miniscrew to form a hook. Intrusive force was applied using nickel-titanium coil springs (Figs 8.21–8.24). Simultaneous retraction of anterior teeth and space closure was started with light and continuous forces delivered by active tiebacks from the anterior hooks on the archwire to the molar attachment hooks.



Fig. 8.21



Fig. 8.22



Fig. 8.23



Fig. 8.24

Once the extraction spaces had closed, an OsteoMed® miniscrew (diameter 1.6 mm, length 6.0 mm) was inserted on the right side in the inter-radicular bone between the mandibular first premolar and first molar (Figs 8.25–8.27). A manual screwdriver was used for placement. Traction (200 g) was applied between the miniscrew and the lower right canine bracket. Both arches were tied back to maintain space closure. The timing of miniscrew placement depends on the planned tooth movement. Miniscrews that serve as anchorage for retraction of anterior teeth are best placed after leveling and aligning of the teeth is complete and before starting active space closure. For this patient, it was difficult to determine the appropriate location of the miniscrew prior to closure of extraction space. When the extraction space had closed, the lower dental midline was still shifted to left side and there was edge to edge contact between the left lateral incisors. Using

traction from the right miniscrew, it was anticipated that retraction of the lower dentition would result in alignment of the midline and would also create adequate anterior overjet.

After 4 months, the lower dental midline was aligned with the upper dental and the facial midlines (Figs 8.28–8.30). Even though the traction force was applied from an apically positioned miniscrew, the intrusive movement was minimal. The use of full-sized rectangular stainless steel archwire and tying the teeth together may have minimized the intrusion of lower right teeth.

Total active treatment time was 23 months. Following removal of the fixed appliances, upper and lower canine-to-canine lingual retainers were bonded. Removal retainers were also given.

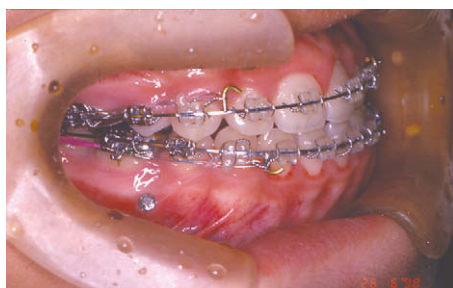


Fig. 8.25



Fig. 8.26



Fig. 8.27

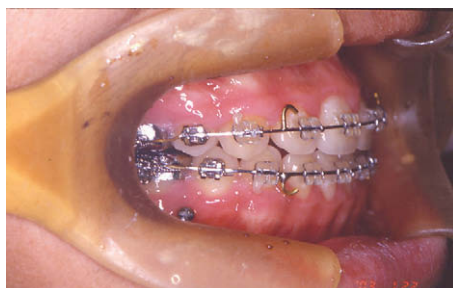


Fig. 8.28



Fig. 8.29



Fig. 8.30

Post-treatment evaluation

The patient's facial appearance improved remarkably. Nose–lip–chin balance was achieved and the chin was no longer recessive (Figs 8.31–8.34). Intraorally, super Class I canine and molar relationships were established.

The upper and lower dental midlines were aligned and a U-shaped upper arch form was attained with coordination of arch widths (Figs 8.35–8.40).



Fig. 8.31



Fig. 8.32

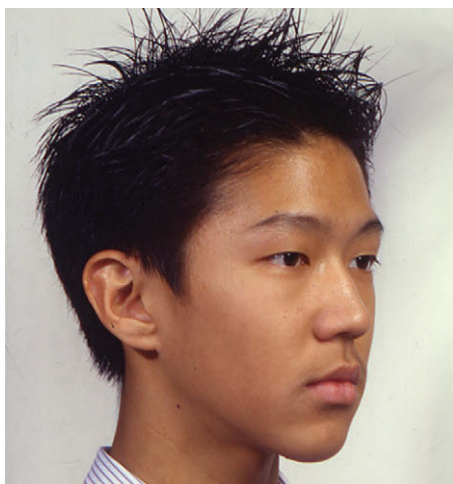


Fig. 8.33



Fig. 8.34



Fig. 8.35



Fig. 8.36



Fig. 8.37

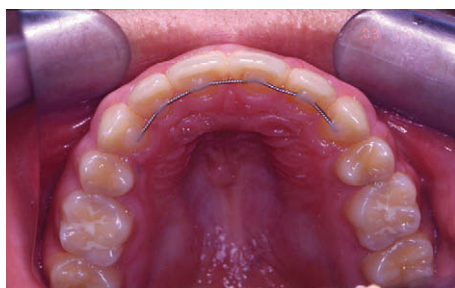


Fig. 8.38

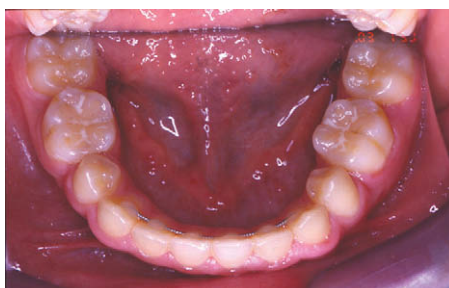


Fig. 8.39



Fig. 8.40

Superimposition of the pre- and post-treatment cephalometric tracings showed reduction in lip protrusion and elimination of mentalis strain. Upper incisors proclination was reduced by 11.5° . There was only 1.0 mm upper molar extrusion. Retraction

of lower incisors allowed the chin point to appear prominent. There was favorable forward and downward mandibular growth during the treatment period although mandibular asymmetry persisted (Figs 8.41–8.44; Table 8.2).



Fig. 8.41

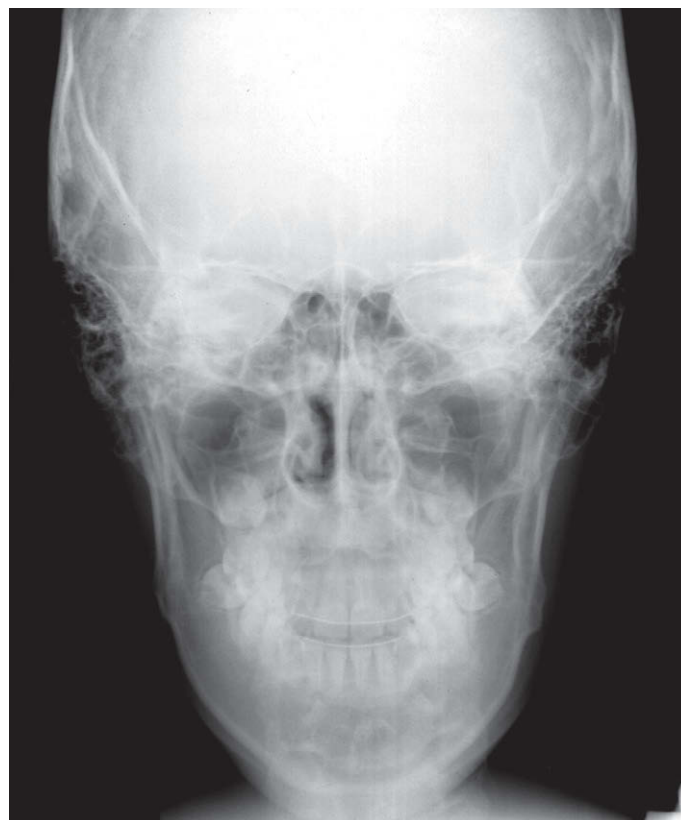


Fig. 8.42

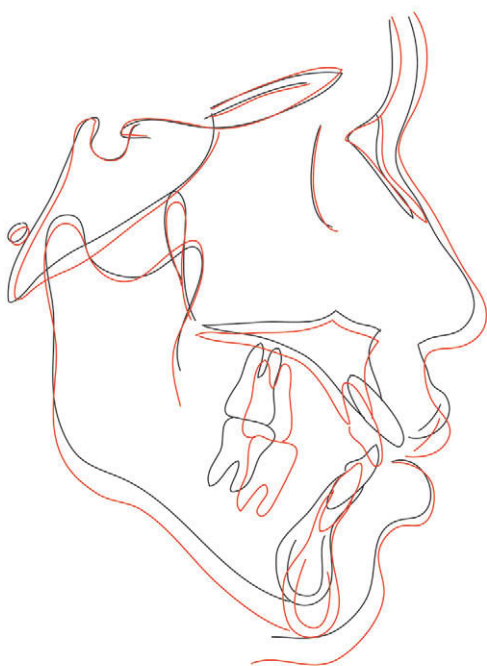


Fig. 8.43

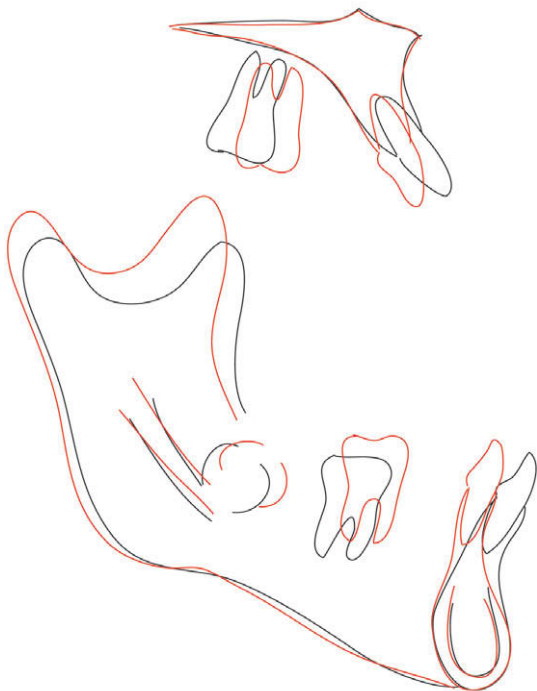


Fig. 8.44

Table 8.2 Pretreatment and post-treatment skeletal, dental and facial cephalometric measurements

	Pretreatment	Post-treatment
SKELETAL ANALYSIS		
Anteroposterior		
SNA (deg)	82.0	81.0
SNB (deg)	78.0	78.0
ANB (deg)	4.0	3.0
Vertical		
GoMe/SN (deg)	40.0	39.0
FMPA (deg)	33.0	34.0
PP/MP (deg)	32.0	32.5
Lower gonial (deg)	79.0	80.0
ANS–Me (mm)	76.5	81.5
DENTAL ANALYSIS		
Overjet (mm)	5.5	4.0
Overbite (mm)	1.0	1.0
UI/SN (deg)	117.5	106.0
L1/GoMe (deg)	93.0	86.0
SN/OP (deg)	18.0	17.5
Is–Is' (mm)	33.0	34.2
Mo–Ms (mm)	27.0	28.0
Ii–Ii' (mm)	49.0	48.5
Mo–Mi (mm)	36.0	42.0
LIP ANALYSIS		
U Lip–E (mm)	3.5	1.2
L Lip–E (mm)	7.5	4.5
NLA (deg)	76.0	79.5

See page ix for Korean norms.
See Table 8.1 and page x for abbreviations.

CASE 8.3

Unilateral intrusion of teeth to level a canted anterior occlusal plane

Presenting complaint and clinical examination

A 26-year-old Korean woman presented with asymmetric gingival exposure. The smile photograph showed canting of the maxillary occlusal plane. The right anterior teeth were relatively extruded and there was a difference in the height of the right and left canines. Hence there was greater gingival exposure on the right side and the upper dental midline was deviated to the left side (Fig. 8.45).

Treatment objectives and plan

The patient refused surgical intervention, and treatment was planned around miniscrew implant anchorage to intrude the right anterior segment.

Treatment

Both arches were bonded with .022/.028 preadjusted fixed appliances, and leveling and aligning started. The archwires were progressively increased up to .019/.025 stainless steel. An OSAS® miniscrew implant (diameter 1.6 mm, length 6.0 mm) was placed in the inter-radicular bone between the upper first and second premolars on the right side. An elastic thread was tied around the upper right anterior hook and posteriorly to the second premolar and then to the miniscrew to apply intrusive force (Figs 8.46, 8.47). The vertical distance between the miniscrew and the archwire decreased as the teeth were intruded (Fig. 8.48).

The asymmetric gingival exposure improved with unilateral intrusion of the upper right anterior segment via miniscrew implant anchorage. The increased elevation of the upper lip on the right side remained after treatment (Fig. 8.49). Gingivectomy in the upper right lateral incisor and canine area would have enhanced the esthetic outcome.



Fig. 8.45

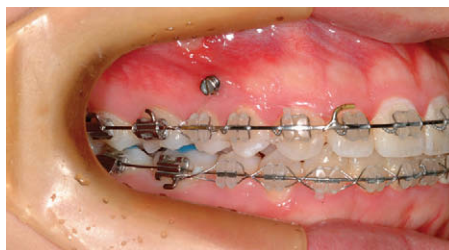


Fig. 8.46



Fig. 8.47



Fig. 8.48



Fig. 8.49

OTHER USES OF MINISCREW IMPLANTS

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INTRODUCTION

The small size of the miniscrew implants allows placement in many locations in the mouth and this is the source of their versatility. With slight modifications to the mechanics employed in the main applications and appliance designs (see Chapters 6–8), miniscrews can be used as adjuncts in a further variety of situations, some of which are covered in this chapter.

Advantages of using miniscrew implants for intermaxillary fixation

No preparation is necessary to secure a location for a stable and rigid fixture.

The miniscrew implants are easily placed and removed, and intermaxillary wires and elastics can be used immediately after insertion.

If orthodontic appliances are not required, oral hygiene is much easier to maintain than with conventional alternative methods of intermaxillary fixation using either buttons or arch bars.

Chair time is reduced; it takes only a few minutes to insert each screw and there is no need for the orthodontist to weld, crimp or solder surgical hooks on the archwires.

USING MINISCREW IMPLANTS FOR INTERMAXILLARY FIXATION

Miniscrew implants can be used for intermaxillary fixation in patients undergoing orthognathic surgery. Multiple archwire hooks are not needed with this method so presurgical orthodontic preparation is simplified. Intermaxillary fixation is also difficult in surgical patients with a lingual orthodontic appliance because there are no attachments available on the labial surfaces of the teeth. Metal buttons can be bonded temporarily to the labial surfaces¹ (Fig. 9.1). However, this can be esthetically unacceptable to such patients. Moreover, intermaxillary fixation via button attachments may cause extrusion of the involved teeth. Archwire hooks can be bonded (Fig. 9.2) but this again can be considered unsightly by the patient. When labial attachments are not acceptable to the patient, miniscrew implants can conveniently be used for intermaxillary fixation.



Fig. 9.1



Fig. 9.2

CASE 9.1

Intermaxillary fixation in a patient undergoing combined lingual-orthodontic and surgical treatment

Presenting complaint and clinical examination

An 18-year-old woman presented with the chief complaint of protruding lower jaw. On examination, she had a skeletal Class III malocclusion (Figs 9.3–9.6).



Fig. 9.3



Fig. 9.4



Fig. 9.5



Fig. 9.6

Intraoral examination revealed missing upper first molars, a midline diastema and a crossbite of all teeth in the upper arch (Figs 9.7–9.11).

Radiographic evaluation

The panoramic radiograph and lateral cephalogram confirmed the clinical findings (Figs 9.12, 9.13).



Fig. 9.7



Fig. 9.8



Fig. 9.9



Fig. 9.10



Fig. 9.11

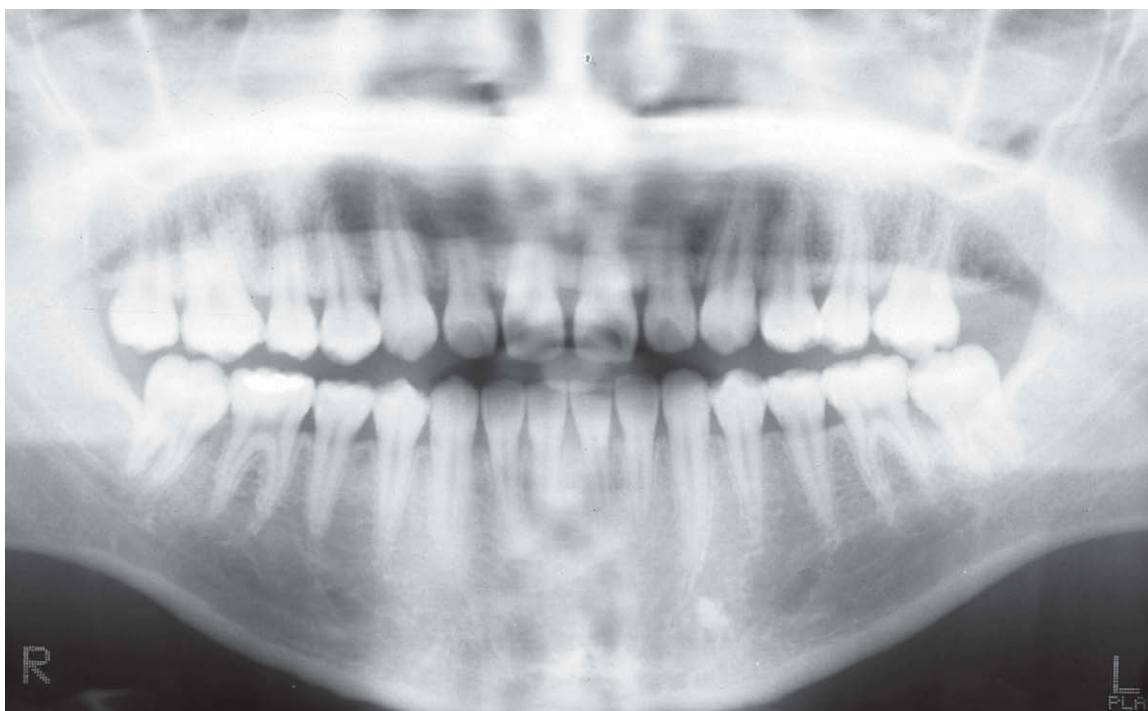


Fig. 9.12



Fig. 9.13

Treatment

Presurgical orthodontic treatment was carried out using .018 Ormco® lingual brackets. Leveling and alignment of both arches was followed by decompensation with Class II intermaxillary elastics (Figs 9.14–9.18).

At 7 months of treatment the patient was ready for orthognathic surgery. Six OsteoMed® miniscrew implants (diameter 1.6 mm, length 6.0 mm) were inserted into the buccal cortical bone in the upper and lower apical regions on both sides. Usually self-drilling miniscrews are inserted directly through the mucosa, either prior to surgery under local anesthesia, or at the time of operation (Fig. 9.19).

When conventional bone screws are used for intermaxillary wiring, the surgical splint holds the intermaxillary wires away from the soft tissues to



Fig. 9.14



Fig. 9.15



Fig. 9.16



Fig. 9.17

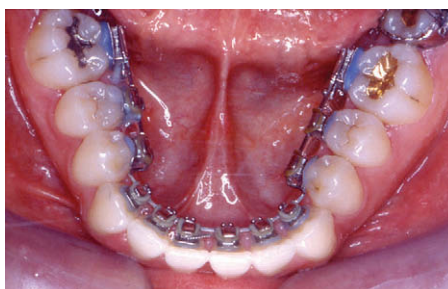
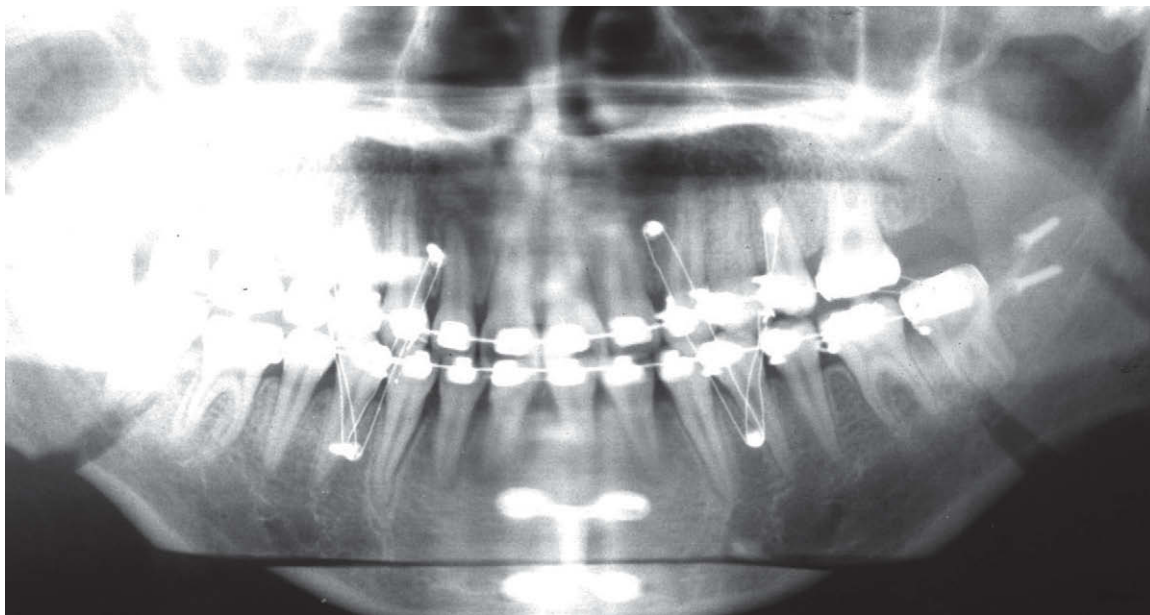


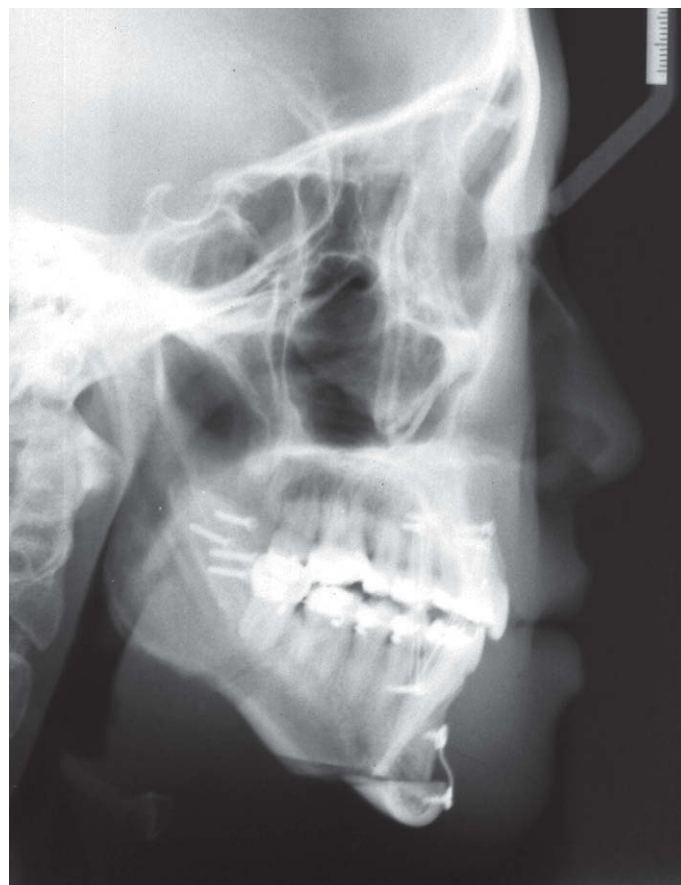
Fig 9.18

**Fig. 9.19**

some extent, but gingival irritation and mucosal impingement are inevitable because of the inherent curvature of the alveolar process (Fig. 9.20).

Mandibular setback surgery was performed, along with advancement and reduction genioplasty (Fig. 9.21).

The miniscrew implants were removed under topical anesthesia after a week of intermaxillary fixation and the orthodontic treatment completed.

**Fig. 9.20****Fig. 9.21**

Post-treatment evaluation

The patient's profile greatly improved, the mentalis strain disappeared, and the teeth were well aligned (Figs 9.22–9.32).



Fig. 9.22



Fig. 9.23



Fig. 9.24



Fig. 9.25



Fig. 9.26



Fig. 9.27



Fig. 9.28



Fig. 9.29



Fig. 9.30



Fig. 9.31



Fig. 9.32

Case 9.1 was previously published in the Journal of Clinical Orthodontics (Paik C H, Woo Y J, Kim J et al. 2002 Use of miniscrews for intermaxillary fixation of lingual-orthodontic surgical patients. Journal of Clinical Orthodontics 36:132–136)

LOCAL TOOTH MOVEMENTS

Another adjunctive use of miniscrew implants is in localized tooth movement for which a partial fixed appliance is preferred. Usually such treatment involves mesial or distal movement of one or two teeth, vertical movement of one or two teeth or uprighting of a posterior tooth. Uprighting a posterior tooth with conventional fixed appliance treatment requires inclusion of the whole quadrant in the appliance set-up and often of the contralateral side as well for appropriate anchorage. Sometimes even a lingual arch is added to supplement anchorage and prevent undesirable tooth movement. Miniscrew implants can reduce the number of teeth involved in the appliance for such treatments.

Clinical tips

Many commercially available orthodontic miniscrew implants have dual heads. These miniscrews keep wires or elastics from contacting the soft tissues, whether or not a splint is present. The protruding miniscrew heads facilitate application of wires or elastics, and it is easier for the patient to maintain oral hygiene (Figs 9.33, 9.34).

Miniscrew implant anchorage can be used for intermaxillary fixation following orthognathic surgery even in patients who have conventional fixed appliances (Fig. 9.35).



Fig. 9.33



Fig. 9.34



Fig. 9.35

CASE 9.2

Minor tooth movement – uprighting a second molar

(Courtesy of Dr Youn Sic Chun, Division of Orthodontics, Department of Dentistry, Ewha Womans University Mokdong Hospital, Seoul, Korea)

A simple application of miniscrew implant anchorage is uprighting of a single mesially tipped molar. Both ends of a sectional .019/.025 stainless steel wire are bent into hooks. One end is bent to a smaller hook, which will be bonded to the anchor tooth. The other end is bent so that the hook fits the miniscrew head (Fig. 9.36).

The length of the sectional wire is determined by the distance between the miniscrew and the molar that will serve as the anchorage unit (Fig. 9.37).

After sandblasting, both the hooks are bonded with composite adhesive, one to the anchor tooth and the other to the miniscrew head (Fig. 9.38).

Presenting complaint and clinical examination

A patient presented with a mesially tipped mandibular second molar (Figs 9.39, 9.40).

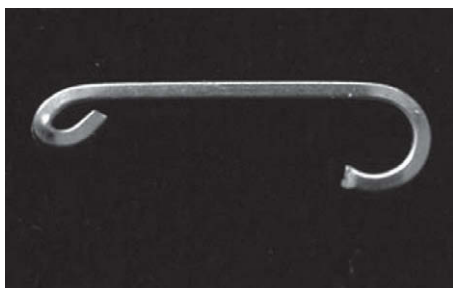


Fig. 9.36

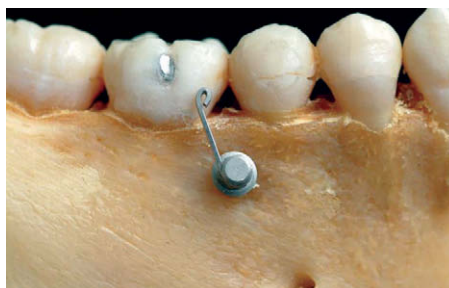


Fig. 9.37



Fig. 9.38



Fig. 9.39



Fig. 9.40

Treatment objective and plan

It was planned to upright the second molar using miniscrew implant anchorage.

Treatment

An ORLUS® miniscrew implant (diameter 1.6 mm, length 6.0 mm) was placed in the buccal alveolar bone between the first and second premolar roots (Figs 9.41, 9.42).

One bent end of the sectional wire was bonded to the mesiobuccal surface of the first molar. (Note that the hook should be bonded sufficiently proximal to allow

space for bonding of the second attachment.) The other hooked end of the sectional wire was bonded to the miniscrew head with light-curing adhesive. To achieve a secure bond, both ends were sandblasted prior to bonding. Connected by this wire, the first molar and the miniscrew served as the anchor unit. A lingual button was bonded on the distal occlusal surface of the mesially tipped second molar. An uprighting segmental spring wire (.019/.025 TMA [titanium molybdenum alloy]) was bent and one end was bonded to the distobuccal surface of the anchor tooth. The free end was activated so that a distal tipping force was generated (Figs 9.43, 9.44).

The second molar was partially uprighted and the occlusal surface was fully visible (Figs 9.45, 9.46).



Fig. 9.41



Fig. 9.42



Fig. 9.43



Fig. 9.44



Fig. 9.45

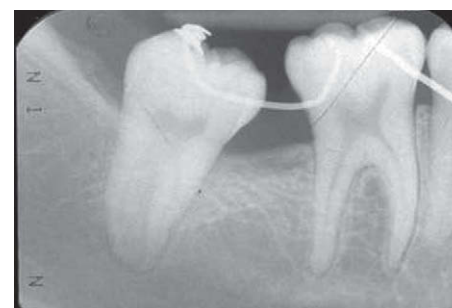


Fig. 9.46

The uprighting spring was removed. Labial attachments were bonded on the first and second molars and a straight wire was placed for further leveling (Figs 9.47–9.49).

Post-treatment evaluation

The second molar was uprighted with the roots parallel with the first molar roots (Figs 9.50–9.52).



Fig. 9.47



Fig. 9.48



Fig. 9.49



Fig. 9.50



Fig. 9.51



Fig. 9.52

CASE 9.3

Mesial movement of a single tooth

Presenting complaint and clinical examination

A 14-year-old Korean girl presented for orthodontic treatment following loss of a carious lower right second premolar. She had previously undergone fixed

appliance orthodontic treatment for 2 years, and there was generalized decalcification of the teeth (Figs 9.53–9.58).



Fig. 9.53



Fig. 9.54



Fig. 9.55



Fig. 9.56

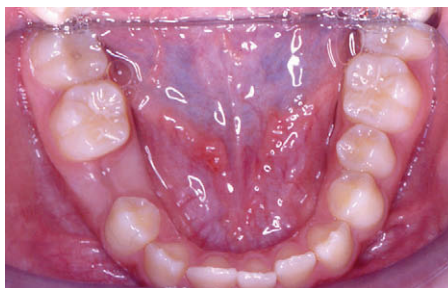


Fig. 9.57

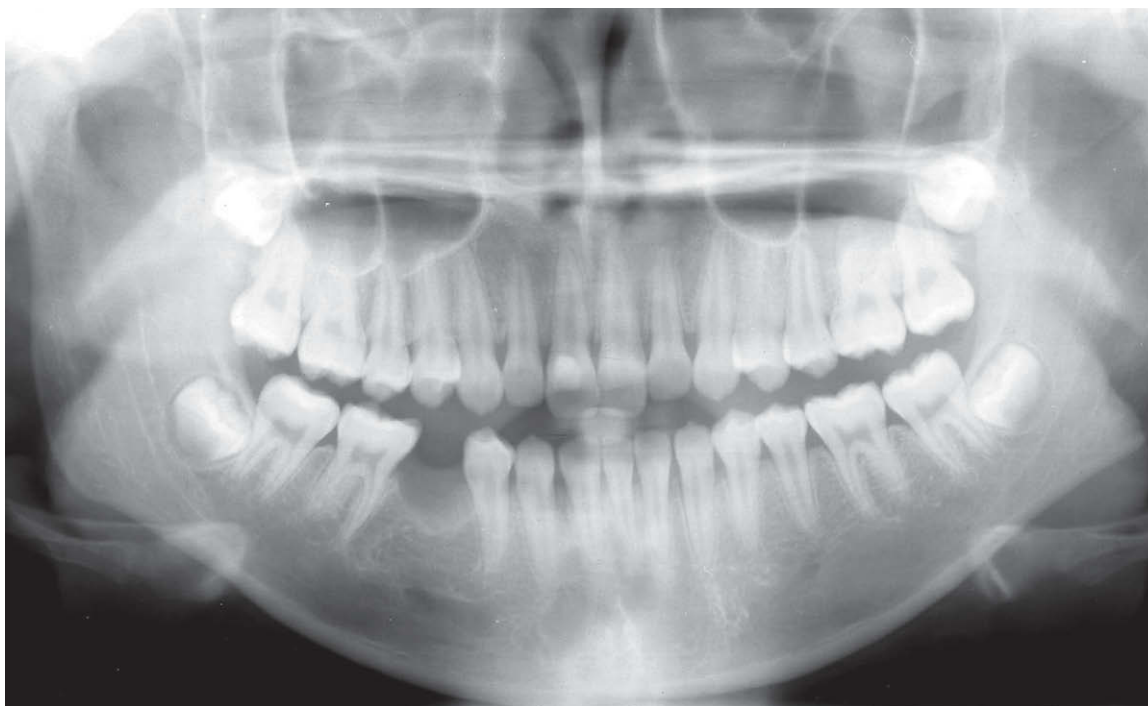


Fig. 9.58

Treatment objective and plan

The aim of treatment was to move the molars forward while involving the least number of teeth with the shortest possible duration of fixed appliance treatment.

Treatment

The lower right first molar was banded; the band had hooks extending to the level of the center of resistance of the tooth on both the buccal and lingual sides. Two OSAS® miniscrew implants (diameter 1.6 mm, length 6.0 mm) were placed in the alveolar bone distal to the first premolar – one each on the buccal and lingual sides. Chains were stretched between the hooks and the miniscrews. The line of force passed through the center of resistance of the tooth (Figs 9.59–9.61).



Fig. 9.59

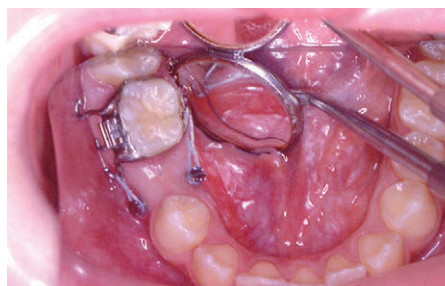


Fig. 9.60

Bodily movement was expected to occur, but the first molar was seen to tip as it approached the first premolar (Figs 9.62, 9.63). The hook on the band was extended further inferiorly so that a mesial moment was created at the root when the chain was applied. The distance between the hook and the miniscrew decreased until finally the miniscrews were removed, and another

miniscrew (ORLUS®; diameter 1.6 mm, length 6.0 mm), was placed in the buccal inter-radicular bone between the lower right first premolar and canine. Sometimes, when bone resistance is encountered before the full length of the miniscrew implant is inserted, complete placement should be avoided, as was the case in this patient. Forced placement can result in fracture of the

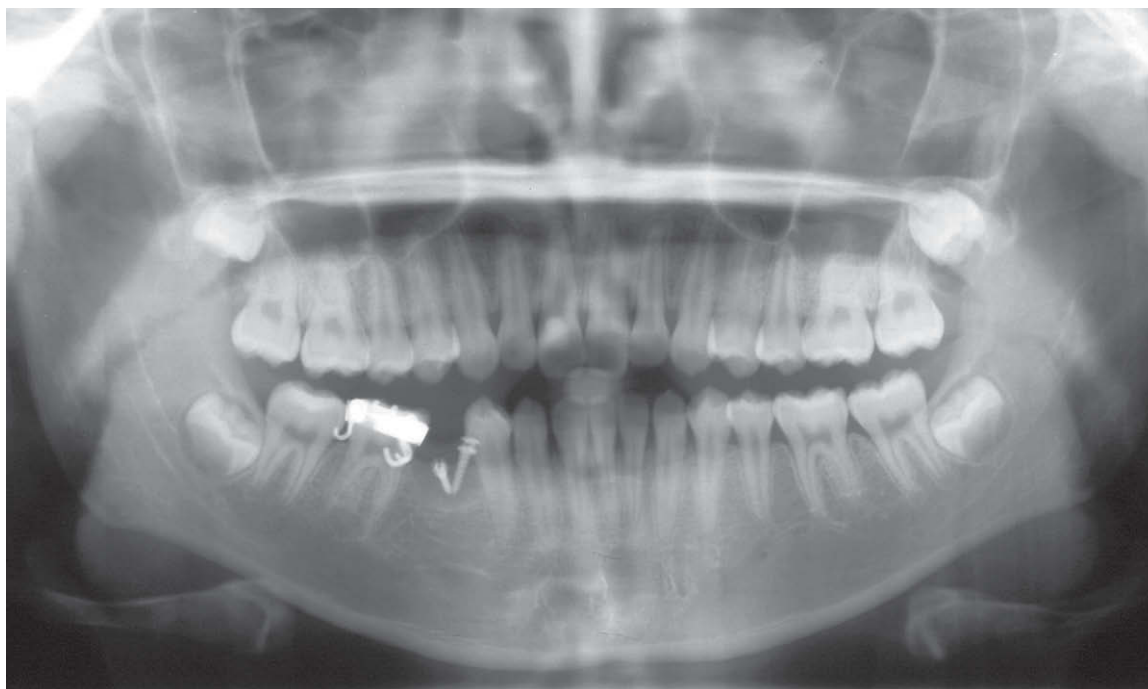


Fig. 9.61

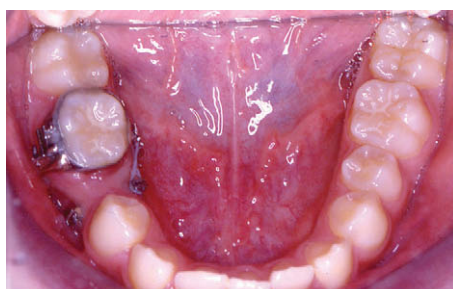


Fig. 9.62



Fig. 9.63

miniscrew. In such situations, the protruding head of the miniscrew can be ground with a high-speed bur to prevent patient discomfort (Figs 9.64–9.66). Further treatment included bonding of the lower teeth with .022/.025 preadjusted appliance.

A chain was continuously applied to the first molar during the leveling and aligning phase of treatment,

resulting in its uprighting and bodily mesial movement (Figs 9.67, 9.68).

Thus, space closure in cases with congenitally missing teeth or with spaces created by loss of carious teeth may benefit from this appliance design.



Fig. 9.64 Full placement of the miniscrew is avoided when there is increased bone resistance, to prevent breakage.



Fig. 9.65 The protruding head has been ground with a high-speed bur to minimize soft tissue irritation.

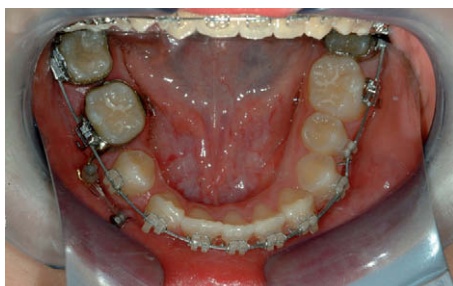


Fig. 9.66

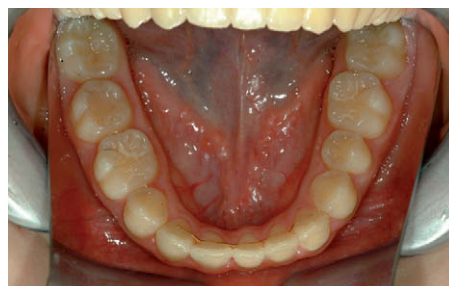


Fig. 9.67

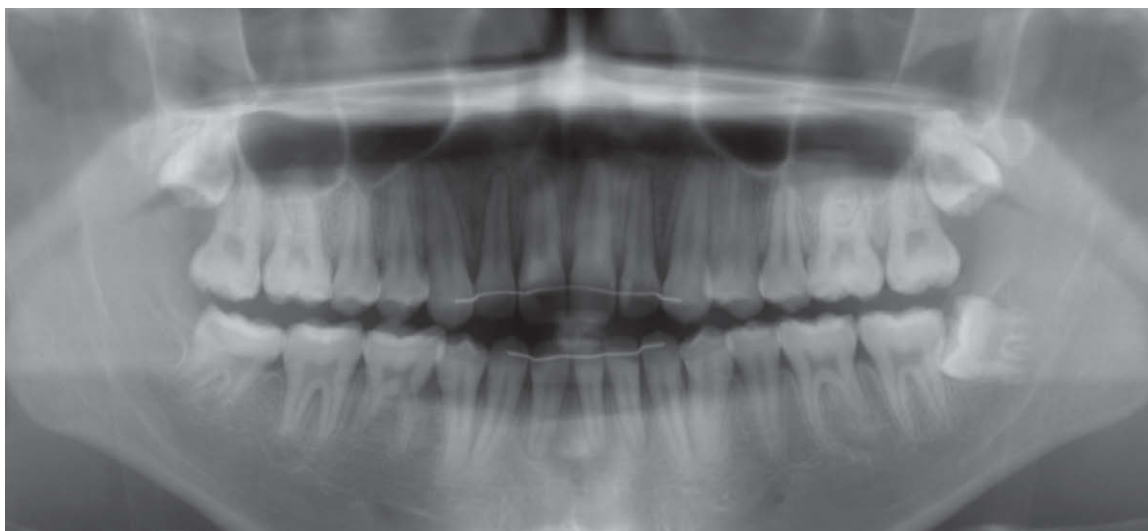


Fig. 9.68

CASE 9.4

Intrusion of a single posterior tooth

Presenting complaint and clinical examination

A 32-year-old Korean woman was referred for preprosthetic orthodontic treatment. There was a

history of incomplete root canal treatment of the lower right second molar and extraction was inevitable. The upper right second molar had supraerupted and there was lack of vertical space for prosthetic replacement of the lower right second molar (Figs 9.69–9.74).



Fig. 9.69



Fig. 9.70



Fig. 9.71



Fig. 9.72



Fig. 9.73

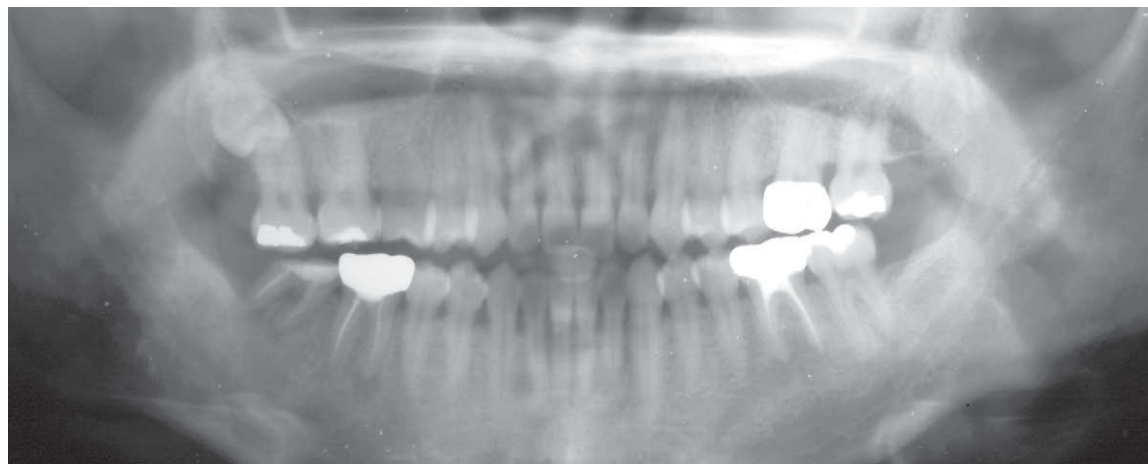


Fig. 9.74

Treatment objective and plan

Intrusion of the upper right second molar was planned.

Treatment

A palatal arch was fitted on the first molars. One OSAS® miniscrew implant (diameter 1.6 mm, length 9.0 mm) was placed in the palatal alveolar bone between the first and second molar roots. A lingual button was

bonded on the second molar. A chain was tied between the miniscrew, second molar and the palatal arch to generate an intrusive force on the palatal side and to negate the extrusive force on the first molar. At the same time an L-loop segment wire was engaged in the bracket and tube on the buccal side to apply intrusive force on this side (Figs 9.75–9.77).

The second molar was intruded successfully, as evidenced by the difference in the levels of marginal ridges of the first and second molars (Fig. 9.77, 9.78).



Fig. 9.75



Fig. 9.76



Fig. 9.77

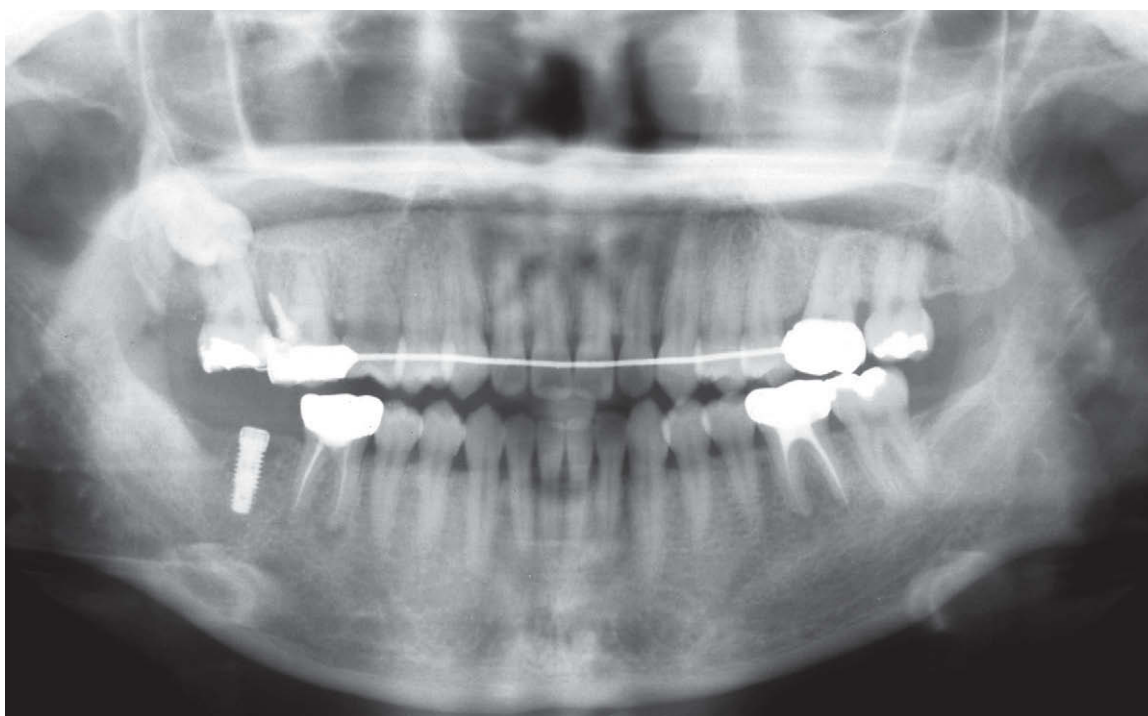


Fig. 9.78

Post-treatment evaluation

Restorative replacement of lower second molar with adequate clinical crown height was now possible (Figs 9.79–9.84).



Fig. 9.79



Fig. 9.80



Fig. 9.81



Fig. 9.82



Fig. 9.83

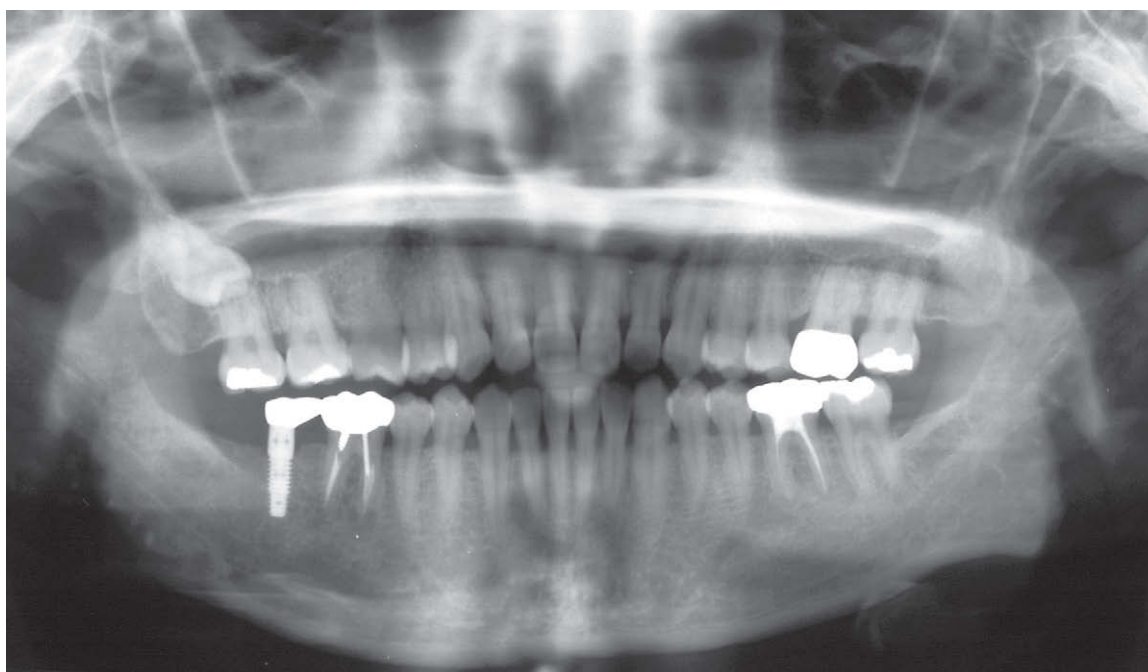


Fig. 9.84

Reference

1. Hong R K, Lee J, Sunwoo J et al 2000 Lingual orthodontics combined with orthognathic surgery in a skeletal class III patient. *Journal of Clinical Orthodontics* 34:403–408

COMPLICATIONS AND THEIR
MANAGEMENT

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This chapter describes some of the potential complications that can occur during insertion, loading and removal of miniscrew implants, and their management.

COMPLICATIONS DURING AND FOLLOWING INSERTION

Damage to anatomic structures

The miniscrew may perforate neighboring anatomic structures such as tooth roots, blood vessels, the nasal cavity or maxillary sinuses. Contact of a screw with a tooth root is frequently signaled by the operator's tactile sense, as the root offers greater resistance to penetration than bone because of its higher density, and the patient's perception of pain during insertion. However, pain during insertion does not necessarily mean the miniscrew has penetrated the root, as the patient may also feel pain if the miniscrew is in the periodontal ligament, which has many sensory receptors. A periapical radiograph should be taken to determine the cause of pain, and an impinging miniscrew should be removed and inserted in a different location. Impingement of the periodontal ligament and even the tooth root itself does not always cause problems – cementum repair has been observed where a root was cut along with regeneration of the periodontal ligament.¹ The damage to the root most probably will not affect the longevity of a tooth as long as there is no pulp damage.² However, the operator should always be careful, paying attention to the tactile sense. Miniscrew placement in a more apical location minimizes root damage as the inter-radicular space increases toward the root apex. Vertical orientation of the miniscrew where the bone volume permits is another way to avoid root damage. A novice operator may take a check periapical radiograph when about half of the miniscrew length has been driven inside the bone.

During insertion in the palatal alveolar area, the greater palatine artery or its branches may be perforated – noted by active bleeding at the site. If this occurs, the miniscrew is removed and pressure is applied to stop bleeding. The miniscrew is placed in a more occlusal location. However, this rarely happens and is usually not a serious problem. The anatomic information and advice in Chapter 5 should be noted.

Use of a longer length miniscrew may result in perforation of the maxillary sinus or nasal cavity during insertion in various areas of the maxilla. Although perforation should be avoided, it has been reported that maxillary sinus perforation resulting from orthodontic screw placement is associated with minimal complications.³

Lack of primary stability

The miniscrew may become mobile immediately after insertion. This is usually due to inadequate thickness of the cortical bone or wobbling of the miniscrew during insertion, both of which weaken the bone–miniscrew contact. Try to insert a miniscrew with a larger diameter (1.6–1.8 mm) in the same location. If this does not help, a different location must be selected.

High resistance to insertion

When the miniscrew is placed in unusually dense bone, it may not be possible to drive it more than half its length because of the increased bone resistance. The midpalatal, mandibular alveolar and retromolar areas are potential sites of dense bone. If the inserted length is judged to be adequate for retention, the full length of the miniscrew is not inserted into the bone to



Fig. 10.1 After grinding the head of a partially inserted miniscrew, a ball-shaped head made of composite can be used for tying the force module.



Fig. 10.2 A miniscrew with its tip broken during its insertion through unusually dense bone.

avoid its breakage. A high-speed diamond bur is used to grind off the exposed part of the miniscrew, including the head part (see Chapter 9, Figs 9.64, 9.65). A ball-shaped composite head can be bonded to the screw to facilitate engagement of elastic chains (Fig. 10.1). Later, a needle holder or pliers should be used to remove the miniscrew as a driver will not grasp the miniscrew.

If a miniscrew is inserted using high torque against dense bone at the start of placement, its tip may fracture (Fig. 10.2). When an attempt is made in the presence of high bone resistance to further insert a miniscrew that is partially inserted, it breaks in the middle (Fig. 10.3). The broken tip can be left in the place if the removal procedure will be invasive, and is not worth the morbidity. Choose a different site for inserting the miniscrew. Fortunately, this occurs rarely. In very dense bone, pilot drilling is done with a small round or fissure bur to make a 1–2 mm deep hole before inserting the miniscrew to minimize its breakage.

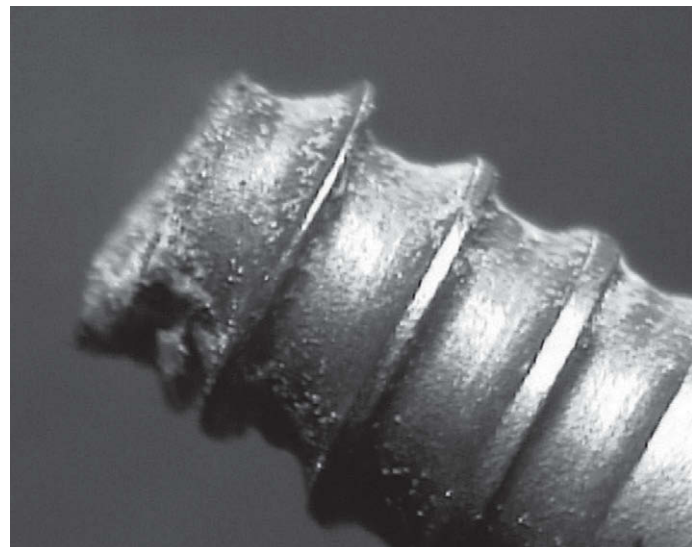


Fig. 10.3 A miniscrew fractured in the middle during insertion through unusually dense bone.

Deflection of the insertion path

When a midpalatal miniscrew is placed using a handpiece in a patient with a transpalatal arch (TPA), the handpiece may collide with the TPA. Thus the angle at which the screw is being driven has to be changed. This may cause wobbling or even fracture of the miniscrew. In such situations, place the miniscrew *before* cementing the TPA and then take a pick-up impression to fabricate the TPA. If the miniscrew has to be placed after the TPA has been cemented, the U loop of the TPA should be made large enough, or a long connecting bur should be used with the handpiece.

Soft tissue problems

As described in Chapters 4 and 5, when an alveolar miniscrew has to be inserted in the unattached mucosa or at the borderline between attached and unattached mucosa, the loose gingival soft tissue tends to wrap around the threads of the miniscrew during insertion compromising its retention. A stab incision prior to placement will prevent this.

In the retromolar pad a full-depth incision is always required because of the thick soft tissue in this region. If there is inadequate undermining, the soft tissue tends to roll around the miniscrew during insertion. It is preferred to refer the patient to an oral surgeon when planning retromolar miniscrew implant anchorage.

Patient discomfort

Besides the pain felt during insertion of the needle for administration of the local anesthetic prior to miniscrew placement, patient discomfort is negligible. Use of topical anesthesia is recommended before administering the local anesthetic. Pain is minimal during and after miniscrew placement. Patients can take an over-the-counter analgesic if they have pain after the anesthesia wears off. Antibiotics are not necessary, except for medically compromised patients.

COMPLICATIONS DURING THE LOADING PERIOD

Mobility of the miniscrew

The miniscrew may become mobile or even loosen. Early miniscrew mobility, which occurs before or soon after loading, is considered a failure, and the miniscrew should be removed and reinserted in another location. Such early mobility may be caused by operator factors (such as wobbling during insertion (Fig. 10.4) or bone damage caused by too rapid insertion) or patient factors (such as active inflammation in the site of placement or local bone remodeling). Early mobility tends to occur more often in growing patients than in adult patients, perhaps because of more active bone remodeling and less bone density. Prevention of wobbling and bone damage is critical to reduce the incidence of miniscrew failure due to mobility. A handpiece should always be used at a controlled, slow speed, and the area should be irrigated with saline if using an insertion speed greater than 30 rpm (Figs 10.5, 10.6).

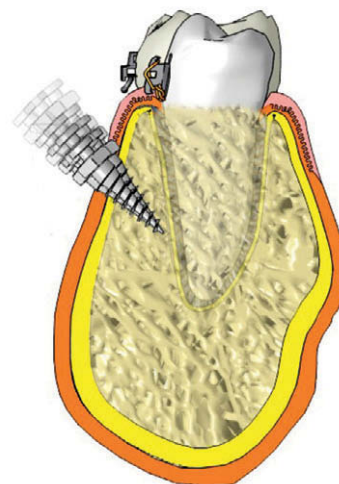


Fig. 10.4 Wobbling must be avoided to minimize miniscrew mobility and failure.

If the miniscrew becomes slightly mobile several weeks or months after orthodontic loading, it does not have to be removed immediately. It can continue to be used unless it irritates the mucosa or is unable to withstand the applied forces. In such cases the miniscrew is passively tied, that is the module should not exert any force on the miniscrew, and the miniscrew is left in place until next visit. At this visit tightening of the miniscrew can be attempted. If it remains mobile, removal is recommended.



Fig. 10.5 Cooling with saline irrigation while using a handpiece.

Varied rates of success of miniscrew anchorage have been reported in the literature and several factors have been reported to be associated with success/failure (Table 10.1). However, further research is needed in this area. In the authors' experience, mobile miniscrews will inevitably fail, and midpalatal miniscrews are associated with the lowest rate of failure compared with other intraoral sites.

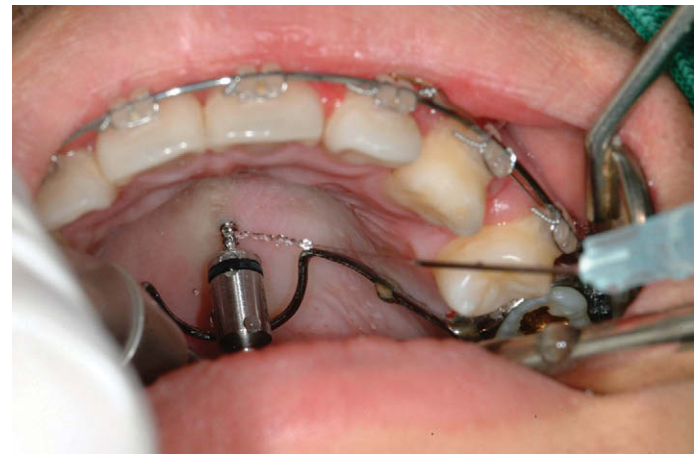


Fig. 10.6 Cooling with saline irrigation during insertion of a midpalatal miniscrew.

Table 10.1 Studies of factors associated with the success and failure of miniscrew implant anchorage				
	Miyawaki et al (2003) ⁴	Woo et al (2003) ⁵	Cheng et al (2004) ⁶	Park et al (2006) ⁷
Miniscrews used	Three types of screws: 1. diameter 1.0 mm, length 6 mm 2. diameter 1.5 mm, length 11 mm 3. diameter 2.3 mm, length 14 mm Miniplate with 2 screws: diameter 2.0 mm, length 5 mm	Surgical double head miniscrews (92): diameter 1.6 mm, length 6 mm (mandible) or 8 mm (maxilla) (OSAS, Epoch Medical) Surgical unihead miniscrews (55): diameter 2.0, length 6 mm (Martin, USA) Pre-drilling for sites with high bone density, otherwise self-drilling	Size of screws: diameter 2 mm, length 5–15 mm (67–Leibinger, Germany; 73–Mondel Implants, Germany) 48 miniplates, 92 freestanding miniscrews Pre-drilling type	Size of screws: 1. diameter 1.2 mm, length 5 mm (Stryker Leibinger Inc, USA) or 1.2/6/8/10 mm (Osteomed, USA) 2. diameter 1.2 mm, length 4/6/7/8/10 mm (Absoanchor, Dentos, Korea) 3. diameter 2 mm, length 10/12/14/15 mm (KLS-Martin USA) Pre-drilling type
Loading		Immediate or 1 week after surgery	2–4 weeks after surgery	
Criteria of success	If orthodontic force could be applied to the implant anchor for 1 year or until completion of orthodontic treatment	Miniscrew not loosened during the loading period of orthodontic treatment	Absence of inflammation Absence of clinically detectable mobility Capability of sustaining the function of anchorage throughout the course of orthodontic treatment	Screw implants that remained in the bone until the end of treatment or until intentional removal regardless of mobility
1-year success rate	Success rate (%) Miniscrews (n) Patients (n) 0 10 3 83.9 101 31 85 23 10 96.4 17 7	86.4% (127/147) in 51 patients	89% (125/140) in 44 patients	91.6% (208/227) in 87 patients
Factors associated with failure of miniscrew anchorage	More failures associated with: miniscrew diameter of 1.0 mm or less inflammation of the peri-implant tissue high mandibular angle (thinner cortical bone)	Age (more failures in patients less than 20 years of age) Insertion instrument (more failures with rotary instrument than hand instrument) Timing of loading (more failures for immediate loading than loading 7 days after surgery)	Anatomic location (more failures in posterior mandible) Character of the soft tissue at the implant site (non-keratinized mucosa predisposed the implants to failure and infection)	Mobility Jaw (more failures for the mandible) Side of placement (more failures on the left side) Inflammation
Factors not associated with failure	Screw length Kind of placement surgery (with or without flap) Timing of loading Location Age and sex Crowding of teeth Anteroposterior jaw relationship Controlled periodontitis Temporomandibular disorder symptoms	Sex Maxilla or mandible Method of insertion (pre-drilling, self-drilling) Shape of head (double head or uni-head)	Age and sex Magnitude of orthodontic load Orthodontic indication Anchor type Implant system used Miniscrew length Oral hygiene	Screw-implant factors (type, diameter, length) Local host factors (occluding gingival positioning) Management (angle of placement, onset and method of force application, ligature wire extension, exposure of screw head, oral hygiene) Age and sex

Poor oral hygiene and inflammation

Poor oral hygiene due to food and plaque accumulation around the miniscrew and force modules (Figs 10.7, 10.8) leads to inflammation in the adjacent soft tissues. The mucosal inflammation and the resultant swelling and hypertrophy around the miniscrew (Fig. 10.9) do not subside spontaneously but continue to worsen if the oral hygiene remains poor. The inflammatory response to a miniscrew placed in unattached mucosa is greater than when placed in attached mucosa as the former is less resistant to inflammation and the mobility of this soft tissue may contribute to this decreased



Fig. 10.7 Food impaction around a buccal alveolar miniscrew.

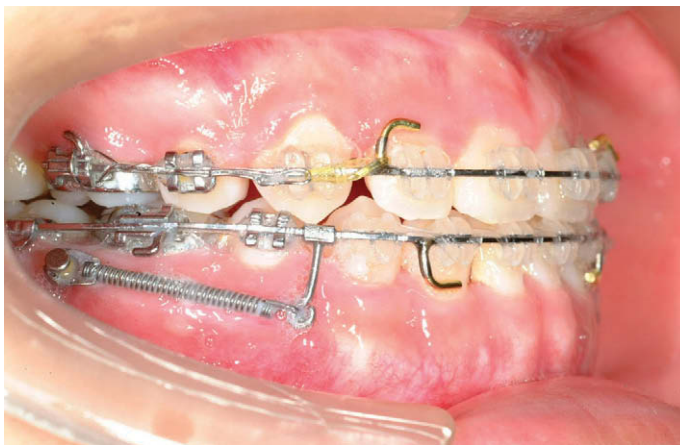


Fig. 10.8 Food impaction around a nickel-titanium coil spring.

resistance. The clinical appearance of inflammation is not proportional to patient discomfort, but the associated swelling may render it difficult to engage force modules on the miniscrew head.

To avoid inflammation, try to insert the miniscrew through attached gingiva. It is important to maintain oral hygiene, and the patient should be instructed to brush around the miniscrew. A toothbrush with extra soft bristles should be given to the patient, because brushing hard with tough bristles may loosen the miniscrew. Care is taken not to tap the miniscrew head with the plastic head of the toothbrush. Minor inflammation around a miniscrew can be usually well controlled by cleaning and dressing with hydrogen peroxide and saline irrigation.

The flabby, hypertrophic tissue around the miniscrew may be removed by a soft tissue laser or electrosurgery, taking care not to touch the miniscrew with its tip; contact between the miniscrew and the tip of the electrosurgical instrument will cause a spark that may startle the patient. Chlorhexidine mouthwash is prescribed to the patient after the procedure.



Fig. 10.9 Mucosal inflammation around a midpalatal miniscrew.

Patient discomfort

If the miniscrew is inserted through alveolar mucosa for anatomic reasons and the closed-pull method is being used, the protruding wire and elastic chain can irritate soft tissue causing discomfort (see Chapter 5, Figs 5.15, 5.16).¹

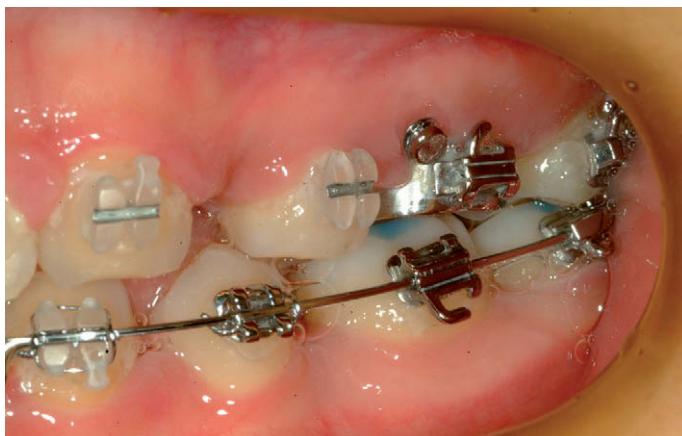


Fig. 10.10 A buccal miniscrew to be removed.

COMPLICATIONS DURING REMOVAL

Potential complications of removal include difficulty in removing a miniscrew due to tight union with the bone and fracture of the miniscrew.¹ However, the authors have rarely encountered such difficulties. The removal torque force is lower than the insertion torque and proportional to the square of the miniscrew radius.⁸ A miniscrew, with its small diameter, has a low removal torque.

The greatest potential problem during removal is pain, specially if mucosal inflammation is present. A topical anesthetic is applied before the miniscrew is removed. Local anesthesia is usually not necessary. The patient should be asked to rinse with chlorhexidine, and the area wiped with an oral disinfectant before and after removing the miniscrew. There is a little bleeding on removal but healing is uneventful (Figs 10.10–10.12).

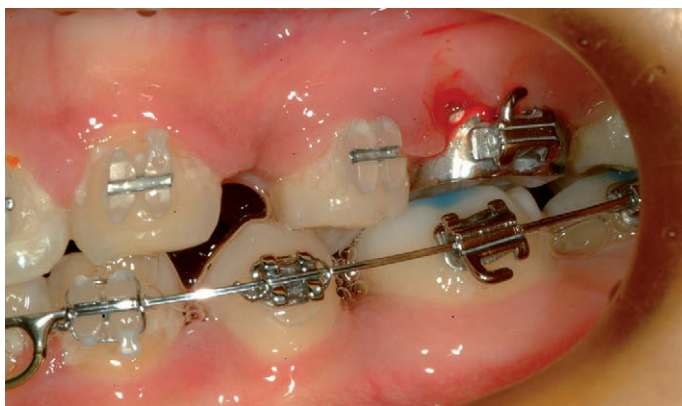


Fig. 10.11 Mild bleeding immediately after removal.



Fig. 10.12 Soft tissue healing after removal.

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